Holographic Cyclic Cosmology: A Rasch Metric Alternative to Conformal Scaling and the 2D production of Negative Mass Dark Energy

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Abstract

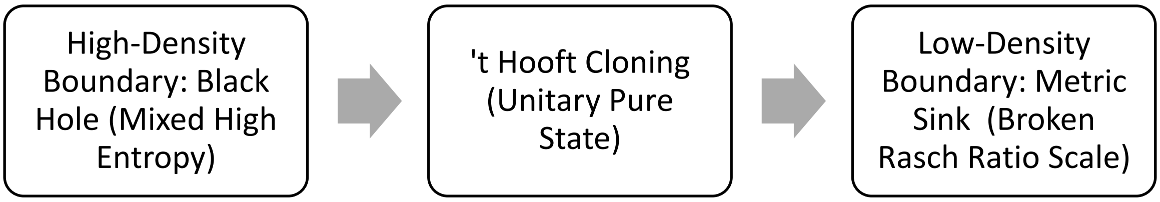
This paper proposes Holographic Cyclic Cosmology (HCC), extending previous work (Fearnley, 2016; Fearnley, 2018). We introduce a mechanism using the sampling mechanics of the Rasch ratio-scale model to explain spacetime metric collapses and cyclic crossovers without requiring Penrose's zero-mass particles or exact conformal scaling laws. By applying 't Hooft's (2022) quantum cloning paradigm, incoming high-entropy matter is compressed and transported across 2D black hole boundaries without encountering localized internal singularities or relying on unstable Einstein-Rosen bridges. The resulting antipodal transport forces a global temporal inversion ($\tau \rightarrow -\tau$). When these pure, low-entropy clones exit into fractured, low-density cosmic sinks—functioning as pseudo-white holes—their structures operate retrocausally. To a forward-in-time observer, this inversion causes the particles to manifest macroscopically as a physical fluid with negative mass (-m). This process establishes a self-sustaining cosmological feedback engine that continuously repopulates empty space, driving accelerated dark energy expansion via runaway acceleration as modelled by Farnes (2018) and Fearnley (2018), ultimately directing the universe toward a multi-node, reheating-free cyclic crossover observable possibly as early "Little Red Dots".

1. Introduction

Modern cosmological paradigms heavily rely on fine-tuned initial parameters and exact geometric scaling laws to resolve structural singularities. In Roger Penrose's Conformal Cyclic Cosmology (CCC), successive cosmic aeons are linked by matching the remote, diluted future of one aeon with the hot Big Bang of the next. However, this classical framework demands a strict, global enforcement of exact conformal invariance and mandates that all physical entities eventually become entirely massless to allow the scale factor to smoothly collapse.

This paper presents an alternative framework: Holographic Cyclic Cosmology (HCC). We show that the transition between cosmic cycles can be achieved without requiring eradication of mass or idealized conformal scaling. Instead, the geometric reset is governed entirely by pure measurement and metric theory.

Our mechanism adapts the mathematical foundations of the Rasch ratio-scale model (Fearnley, 2016). Originally formulated within measurement theory to explore scale origins without cosmological context, the Rasch model reveals a profound architectural paradox: a physical ratio-scale cannot form if the underlying data configurations become too uniform or perfectly non-overlapping. When applied to spacetime geometry, this scale-fracturing condition replaces the global masslessness criteria of CCC. The spatial metric degrades naturally whenever physical matter reaches a critically low vacuum density. Rather than a singular, sudden global event, this model supports multiple, localized metric fractures.



To prevent the total disintegration of cosmic structure, these low-density metric fractures must be continuously repopulated. Traditional general relativity attempts to link high- and low-density regions using Einstein-Rosen bridges or wormholes; however, these geometric structures are inherently unstable and physically incapable of safely transporting matter across scale boundaries.

HCC resolves this transport problem by utilizing Gerard 't Hooft's (2016, 2022) holographic quantum cloning across black hole event horizons. By processing infalling matter entirely along the 2D horizon boundary, quantum states are cloned onto an antipodal receiving space without encountering a central coordinate singularity. Crucially, this antipodal identification forces a global inversion of the temporal vector ($\tau \rightarrow -\tau$).

When these low-entropy, pure-state clones exit into the fractured, low-density spatial sinks—functioning as gentle, pseudo-white holes—this temporal inversion causes the emitted antimatter particles to manifest dynamically as a physical fluid with negative mass ($-m$). This unified mechanism provides an explicit physical origin for the negative-mass dark matter and dark energy fluids proposed in the simulations of Farnes (2018) and Fearnley (2018), driving the accelerated expansion of the universe toward its next cyclic node.

Comparison Feature	Penrose Conformal Cyclic Cosmology (CCC)	Holographic Cyclic Cosmology (HCC)
Trigger Mechanism	Universal mass eradication and absolute redshifting	Volumetric matter dilution past a critical density threshold
Mass Requirement	Particles must become strictly massless ($m = 0$)	Particles retain positive inertial mass
Geometric Scale	Strict, global enforcement of conformal invariance	Variable ratio-scale metric that fractures under sparse data
Transition Nature	Sudden, synchronized global crossover event	Progressive multiple localized losses of scale (micro-nodes)
Reheating Phase	Requires a chaotic high-entropy reheating mechanism	Instantaneous small-volume restart via pure quantum states

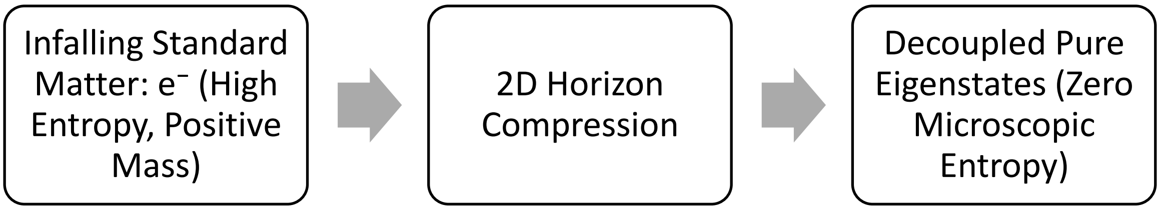
2. The Black Hole Horizon Engine and Unitarity Restoration

The traditional description of matter falling into a black hole encounters immediate tension with quantum mechanics via the black hole information paradox. To construct a singularity-free, cyclic cosmology, our framework replaces classical interior collapse with a 2D horizon transport mechanism based on the quantum cloning and antipodal identification models introduced by Gerard ’t Hooft (2018, 2022).

2.1 Microscopic Entropy Suppression

Standard macroscopic matter infalling toward a black hole consists of mixed quantum states characterized by high thermodynamic and statistical entropy.

For example, consider a standard, forward-in-time positive-mass electron (e^-) approaching the 2D event horizon. The extreme gravitational configuration triggers a dimensional reduction, compressing the 3D state data of the particle onto the 2D bounding surface.



During this horizon compression, the complex, mixed thermal profiles typically associated with Hawking radiation are bypassed. By using a microcanonical ensemble description, the horizon acts as an information filter: it strips away the chaotic macroscopic configurations and leaves only the bare and unentangled eigenstates. The local interaction—mediated by the gravitational Shapiro time delay algebra—collapses the data down to zero microscopic entropy.

2.2 Unitarity via ’t Hooft Quantum Cloning

A significant hurdle in cyclic models is the transport of matter through black holes. Standard general relativity relies on Einstein-Rosen bridges or wormholes, which are dynamically unstable and require unphysical exotic matter to remain open.

To overcome this, we adopt ’t Hooft’s 2022 formulation, which shows that the quantum wave functions of Region II in a black hole Penrose diagram are exact quantum clones of the states in Region I.

Region I (Horizon Entrance) → (No Interior Entry) → Region II (Horizon Exit) (Exact Pure State Quantum Clone)

This cloning mechanism offers two fundamental advantages for our Holographic Cyclic Cosmology (HCC):

- Singularity Avoidance: Infalling particles do not physically cross into the interior volume of the black hole or collide with a central coordinate singularity. Information is preserved entirely on the boundary.

- Pure State Unitarity: Because all quantum states in Region II are exact clones generated deterministically by the boundary algebra, the evolution remains completely unitary. The black hole successfully handles highly disorganized matter and transforms it into low-entropy, pure-state cloned outputs.

2.3 The Antipodal Boundary and Temporal Reversal

Crucially, ’t Hooft’s framework dictates that Region II maps directly to the angular antipodes of Region I, introducing a vital topological twist. When the pure clone is processed across the horizon to the antipodal receiving end, the boundary conditions demand an exact time-reversal switch.

Time Vector Inversion**:** (+t) → (-t)

This antipodal coordinate identification avoids the formation of a physical firewall. The particle does not exit into a standard spatial zone; instead, it is ejected into an antipodal space where its forward time vector is flipped.

3. Micro-to-Macro Transition and Particle Inversion

Once information is processed at the black hole boundary, the pure-state clones must exit back into macroscopic space. This stage establishes the physical manifestation of the antipodal time-flip, defining how these cloned states repopulate the universe.

3.1 The Pseudo-White Hole Discharge

Because ’t Hooft’s framework bypasses internal singularities, the cloned particles do not undergo a standard Hawking evaporation decay over trillions of years. Instead, the antipodal boundary mapping creates a unidirectional quantum flow.

Black Hole Horizon → Antipodal Shift → Spatial Sink Breakouts → High-Density Input → Low-Density Pseudo-WH

The cloned particles are ejected out of the black hole system entirely. However, they do not emerge randomly; they break out into specific spatial sinks where the background Rasch spatial metric has broken down or fractured due to critically low matter density. These exit zones function as localized, low-density pseudo-white holes residing inside deep intergalactic voids or near the extreme, diluted end of a cosmic cycle.

3.2: Quantum Clone Inversion and Laboratory Trajectories

Upon exit through the antipodal boundary, the pure clone carries an inverted internal time vector ($-\tau$). For a standard observer moving along our forward universal timeline ($+t$), this flipped temporal orientation alters the particle's observable quantum identity.

- CPT Symmetry Constraints: In standard quantum field theory, reversing the direction of time is mathematically linked to charge conjugation and parity inversion.
- The Antimatter Shift: Consequently, if the infalling particle was a standard electron (e^-), the clone emerging into the low-density spatial sink is naturally perceived by forward-time observers as a positron (e^+).

An empirical objection may be raised regarding standard terrestrial laboratory experiments (such as those at CERN) that attempt to determine whether antimatter falls up or down to prove its mass sign. However, this objection relies on a flawed premise.

Earth possesses an overwhelming mass compared to an individual subatomic antiparticle in a laboratory. Because Earth’s massive gravitational field attracts everything, it will inevitably pull the antiparticle downward along with it. Consequently, it is impossible to definitively determine in a local laboratory whether an individual particle mass carries a positive ($+m$) or negative ($-m$) sign simply by observing its downward trajectory.

The true, unmasked nature of this negative mass only becomes dynamically evident far from the laboratory [2.1]. It is exclusively within the profound emptiness of low-density interstellar or intergalactic regions—or near the end of a cycle in an HCC model—that these emitted particles can freely express their repulsive negative mass characteristics to drive cosmic expansion.

4. Cosmological Dynamics and the Runaway Expansion Feedback Loop

4.1 Spatial Relativity, Measurement Error, and Metric Fracture

To formalise how spatial intervals break down at the end of an aeon, we apply the sampling mechanics established in Fearnley (2016). Rather than treating coordinate space as an absolute, predetermined grid, the background metric is understood as an emergent phenomenon constructed from observational data. We establish a fundamental distinction between the true object positions within an underlying population and the sampled metrics constructed from observations. This relationship introduces a distinct relativity problem governed entirely by the magnitude of localized measurement errors:

- High-Density Binding via Large Errors: When physical objects exist in a state of high local density, the measurement errors are relatively large compared to the minuscule distances separating the true object positions. These large errors cause the sampled positions to overlap constantly by chance, making the objects appear highly local and clustered. This statistical overlap binds the observed coordinates together, generating a continuous, stable physical ratio-scale metric equivalent to standard spacetime geometry.

- The Non-Local Zero-Error Singularity: As cosmic expansion drives the universe into extreme emptiness, the true underlying object configurations become vastly isolated, resulting in low density. In this state, measurement errors become infinitesimally small relative to the enormous gaps between positions. Because there is no chance for the sampled data to overlap, the positions never intersect, causing the system to appear strictly non-local and separated.

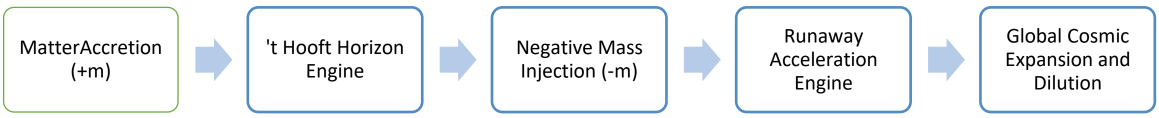
If the data follow this perfect, stark population distribution too exactly—reducing observational error variance to a localized zero—a profound mathematical paradox emerges. Without a baseline of overlapping measurement errors to statistically bind the coordinates together, the mechanism required to establish a continuous interval breaks down. The metric can no longer compute relative distances. The sampled data collapses into a crude ordinal scale (merely establishing sequence), but the continuous ratio- or physical-scale metric completely fractures.

This localized fracturing of the physical scale under extreme, non-local matter dilution creates the low-density boundary sinks (pseudo-white holes) necessary to trigger the trans-horizon injection of negative-mass particles.

4.2 The Runaway Acceleration Engine and Mass-Conversion Dynamics

In classical general relativity, the behaviour of negative mass fluids faces intense academic scepticism due to the phenomenon of runaway pair creation. Under standard conditions, if a positive mass particle (+m) and an equivalent negative mass particle (-m) are placed near one another, the gravitational interaction causes the negative mass to repel the positive mass, while the positive mass attracts the negative mass. The pair undergoes constant, uniform acceleration in a single direction indefinitely, a result frequently flagged as a pathological violation of energy conservation.

In our framework, this runaway effect is not an error or a stability problem; it is the fundamental dynamic driver of cosmic expansion.



When 't Hooft's horizon engine ejects negative-mass clones into low-density space, they exist as real, discrete physical entities. They engage in mechanical runaway interactions with surrounding standard matter, creating an irreversible repulsive pressure across the cosmos. The infinite acceleration vector of these physical runaway pairings forces standard positive-mass structures apart at an exponential rate, driving expansion without a cosmological constant.

As the universe expands, standard macroscopic matter is steadily funnelled toward local black hole horizons. This accretion triggers more 't Hooft cloning, systematically converting high-entropy positive mass into low-entropy negative mass. This runaway engine operates continuously until the universe reaches a critical threshold where virtually no standard positive mass remains to be converted, starving the runaway engine of fuel and triggering the global Rasch metric breakdown.

4.3 Multi-Node Aeon Construction and the "Little Red Dot" Coalescence

The final transition out of an empty aeon avoids a singular, uniform global big bang. Because the Rasch spatial metric degrades locally in response to patchy, uneven matter dilution, the breakdown of the physical ratio scale occurs at multiple distinct, localized coordinates throughout the universe rather than a single, synchronized global point.

Multiple Rasch Scale Fractures → Localised Finite Spots → Space Expansion and Growth → End of Aeon → Reheating-Free Seeds (Coalescing Into New Aeon)

When the global universe approaches its final empty threshold, the final transport of near-zero entropy pure quantum states does not focus into a singular mathematical coordinate point. Instead, the broken Rasch scale restarts at several highly compressed finite spots. Because the cloned particles exiting into these fractured spots are already in near-zero entropy pure states, they do not require an industrial, high-entropy "reheating" phase. Spacetime instantly begins expanding and growing outward directly from these distinct, localized spatial origins.

This multi-node spacetime birth possibly offers a radical, direct physical explanation for the mysterious "Little Red Dots" (LRDs) discovered by the James Webb Space Telescope in the early universe. Observed as ultra-compact, highly massive objects existing within the first 600 million years post-transition, traditional cosmology struggles to explain how such massive seeds could form so quickly. Under the HCC model, these Little Red Dots could possibly be the literal spatial footprints of the multi-node crossover. They represent individual, high-density finite spots where independent regions of the new spacetime metric began growing. As these distinct bubbles of space expand, their local Rasch physical ratio scales expand with them, eventually aligning and fusing to stitch the independent bubbles into a single, continuous, and cohesive macroscopic universe.

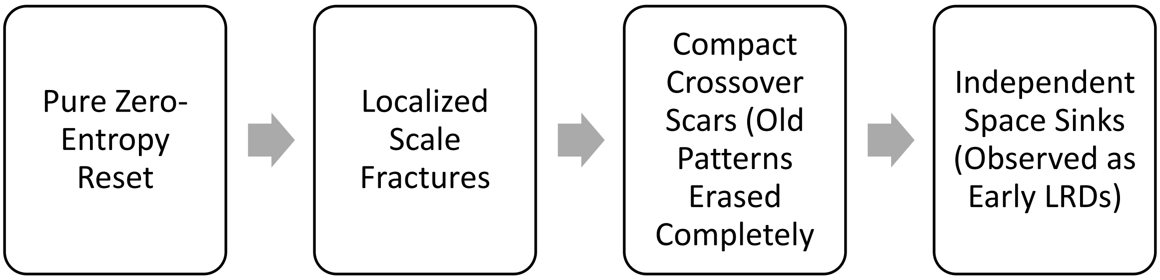
5. Conclusions and Future Work

This paper establishes Holographic Cyclic Cosmology (HCC) as a singularity-free, unitary alternative to standard conformal models. By utilizing a Rasch ratio-scale metric, we have demonstrated that cosmic crossovers do not require absolute mass eradication or fine-tuned conformal transformations. Instead, spatial scale degradation is a natural, geometric consequence of extreme matter dilution. (See Appendix.)

The integration of ’t Hooft’s antipodal quantum cloning resolves the information paradox while providing a continuous microstructural engine for the cosmos. High-entropy matter processed at 2D black hole boundaries is converted into near-zero entropy, clones. Discharged into low-density metric fractures (pseudo-white holes), these states manifest macroscopically as a physical, negative-mass fluid—simultaneously driving dark energy.

The most pressing observational frontier for HCC lies in formalising the signature of the multi-node crossover. Roger Penrose’s standard Conformal Cyclic Cosmology (CCC) has historically relied on searching for concentric gravitational wave rings in the Cosmic Microwave Background (CMB) as evidence of pre-aeon collisions. However, this approach suffers from a severe thermodynamic contradiction. If a cyclic transition truly collapses the universe down to a state of zero microscopic entropy, the macroscopic "memory" and chaotic radiation patterns of the previous aeon must be entirely erased. It is physically impossible for highly structured CMB anomalies to have survived a clean entropy reset.

HCC completely resolves this paradox. Instead of attempting to preserve old structural data across a zero-entropy boundary, our future work will mathematically model the initial geometry of the new aeon as a product of multiple independent spacetime origins. Because the Rasch physical ratio scale fractures locally under uneven vacuum dilution, the new cycle initiates at several distinct, highly compressed finite spots rather than a singular, synchronized global singularity.



We hypothesize that these independent coordinate bubbles may provide a direct, elegant explanation for the ultra-compact, hyper-massive "Little Red Dots" (LRDs) discovered by the James Webb Space Telescope in the early universe. Rather than anomalous structures that somehow grew overnight in a perfectly smooth background, these objects are the literal crossover scars of a multi-node genesis. Our immediate computational agenda will focus on analysing the precise boundaries where these independent Rasch metrics align and fuse into a continuous macroscopic universe, predicting the exact mass-to-volume ratios of early LRD clusters to establish a clean, testable observational signature that completely bypasses the pattern-survival requirements of standard conformal models.

References

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Appendix

The Non-Orthogonal Parallel Rasch Architecture

Instead of there being a fixed, pre-existing 3D continuous space, the universe, somewhere unknown in the deep universe, appears to calculate spatial relationships on the fly using three independent 1D Rasch measurement programs running simultaneously.

- Arbitrary orientations: The three axes do not need to be locked at static 90^{o} right angles. They are completely arbitrary, relational vectors.

- Variable lengths: The "length" or scale of each axis is not a fixed background constant. Because the Rasch model calculates *probabilities* of relational intervals, the scale of each axis can stretch, contract, or fluctuate dynamically based on the local energy density—such as the massive gravitational focus points of the Little Red Dots (LRDs) maybe inheriting their "DNA" from the 't Hooft antipodal bounce.

- The emergent 3D arena: Just as a game engine synthesises a rich 3D world by processing independent linear code streams, our physical 3D space emerges naturally where these three arbitrary, dynamic 1D Rasch-like programs intersect.