Stratal Spacetime and Cosmological Questions

Geometric construction and open conjectures

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Outline

This talk

Goal. Propose a *cosmological extension* of the grain program: from the 2D stratal plane to a 4D spacetime structure with a 3-spherical boundary.

Two construction steps.

1. **Intrinsic rotation** around Δ_∞: 2D $\to$ 3D (stratal space).
2. **Temporal integration** of an evolving 3D ball: 3D $\to$ 4D (stratal spacetime $\bar{B}^4$).

Resulting structure.

- Spacetime $\bar{B}^4$ with boundary $\partial\bar{B}^4 = S^3$.
- The trace of Δ_∞ in S^3 is a great circle, the locus of matter/antimatter encounter.

Epistemological status. The geometric framework is coherent and well-defined. The dynamics (matter feedback, cosmological evolution, informational role of the boundary) are *explicitly conjectural*.

The analogy with functional stratification

General relativity. Matter curves spacetime via Einstein's equations:

$$R_{\mu\nu} - \frac{1}{2}Rg_{\mu\nu} = \frac{8\pi G}{c^4}T_{\mu\nu}.$$

Functional stratification theorem (grain program). Any differentiable function f locally stratifies the codomain axis by the factor $|f'(x)|$ (cf. Cartesian anomaly).

Suggestive analogy. Matter acts as a *local stratification factor* on spacetime: its presence locally modifies the metric.

Important caveat. This analogy is *suggestive, not constructive*. It motivates the search for a stratal cosmological framework but does not construct it. The work that follows is a geometric construction within the grain program, not a derivation of general relativity.

Available ingredients

To construct a stratal cosmological model, we mobilize:

From the grain program.

- The *universal flow* Γ and its mirror $\bar{\Gamma}$.
- The *carrier circles* C_k and their mirrors $\bar{C}_k$.
- The *line at infinity* Δ_∞ (Volume II).
- The *stratal levels* $\mathcal{G}_{-kn_\infty}$.

From physical interpretations.

- The *time* $=$ *intra-grain cycle* identification (cf. note on Planck's constant).
- The *matter/antimatter* conjecture (Γ vs $\bar{\Gamma}$).

Two-step strategy.

- Intrinsic rotation $\to$ stratal 3D space.
- Temporal integration $\to$ stratal 4D spacetime.

Intrinsic rotation around Δ_∞

Definition (Intrinsic rotation)

Consider the *intrinsic rotation group* of the ambient space around the line at infinity Δ_∞, treated as an axis. Concretely, Δ_∞ is embedded as an axis in $\mathbb{R}^3$, and the group acts by rotating the working plane around this axis.

Physical interpretation. Not a rotation applied to an external frame, but an *intrinsic rotation of space itself* around its axis at infinity. It adds a geometric dimension to the working plane, elevating 2D structures to 3D structures.

Consequence on carrier circles.

- Each carrier circle C_k is tangent to Δ at O.
- Δ_∞ passes through O.
- Under rotation, C_k generates a *torus* Γ_k^2.

Tori with null collar

Proposition (Generation of tori)

Under the action of the rotation group around Δ_∞, each carrier circle C_k generates a torus Γ_k^2. Since the circles C_k are tangent to Δ at O and Δ_∞ passes through O, the torus Γ_k^2 is *with null collar* (pinched torus).

Geometry of the null-collar torus.

- Obtained by rotating a circle around an axis *tangent* to the circle.
- Topologically: a pinched sphere (no inner hole).
- Geometrically: a closed surface meeting at the tangency point.

Nested family. The tori Γ_k^2 form a nested family:

$$\Gamma_1^2 \subset \Gamma_2^2 \subset \dots$$

with increasing radii.

Encapsulating spheres

Proposition (Concentric spheres)

For each carrier circle C_k and its mirror $\bar{C}_k$, there exists a circle $\widehat{C}_k$ centered at O that *encapsulates* them: contains both in its interior disk.
Under the rotation group, each encapsulating circle $\widehat{C}_k$ generates a *sphere* S_k^2 *centered at* O. These spheres form a concentric family:

$$S_1^2 \subset S_2^2 \subset \dots$$

Non-dense sequence. At resolution $-n_\infty$, the sequence of spheres S_k^2 is *not dense* in space — there are "gaps" between spheres. This limits the immediate utility of the model. Passing to finer resolutions is necessary.

Density at fine levels

Proposition (Density at levels $-kn_\infty$)

By applying the mechanism at resolution levels $-kn_\infty$ with $k \geq 1$, the sequences of tori Γ^2 and spheres S^2 become *dense*. In this stratified limit, the tori and spheres fill the ambient space and form:

- A *solid torus* Γ^2 (dense union of nested tori).
- A *closed ball* $\bar{B}^3$ encapsulating this solid torus (dense union of interior disks of the spheres).

The 3D ambient space is thus stratally reconstituted as a ball $\bar{B}^3$ containing a solid torus Γ^2.

Why does this work? The structural argument: *factorizations of the continuum allow exiting zero*. Established in the grain program (cf. topo-set-theoretic remarks), this property guarantees that densification at levels $-kn_\infty$ is not arbitrary but instances a structural mechanism: grains of zero measure at the higher level become non-zero lengths at the lower level.
In the cosmological context, this guarantees that $\bar{B}^3$ is an object of *non-trivial geometric substance*, not a mere union of zero-measure spheres.

Identification time / intra-grain cycle

From the note on Planck's constant.

- *Space* is measured by inter-grain displacements.
- *Time* is measured by intra-grain displacements (cycles on the unit circle).

Definition (Stratal dilatation)

Assume the existence of a *continuous dilatation of grains*: the grains $\mathcal{G}_{-kn_\infty}$ grow in size as a function of a temporal parameter $\phi \in [0, 1]$.
Since the grain size governs the size of the ball $\bar{B}^3$ containing them, this dilatation translates into an *expansion of $\bar{B}^3$ in time*.

Cosmological reading. The stratal dilatation is the stratal analog of the observed Hubble expansion: the universe grows not by displacement of matter in a fixed space, but by *intrinsic growth of the geometric grid itself*.

The integration mechanism

Proposition (Family of balls)

Parameterize $\bar{B}^3$ in temporal evolution by $\phi \in [0, 1]$:

$$\bar{B}^3(\phi) = \{(x_1, x_2, x_3) \in \mathbb{R}^3 : x_1^2 + x_2^2 + x_3^2 \leq 1 - \phi^2\}.$$

At $\phi = 0$, the ball is maximal (radius 1). At $\phi = 1$, it reduces to a point. The parametrization describes a continuous temporal evolution of 3D stratal space.

Sign convention. This parameterization describes a *contraction*. For an expansion model, one inverts the direction of the parameter. What follows is independent of the sense: only the geometric structure of the family matters.

Next step. Integrate the characteristic function of $\bar{B}^3(\phi)$ over ϕ to obtain a 4D structure.

Passage 3D $\to$ 4D by temporal integration

Theorem (Central result)

The integration of the characteristic function of $\bar{B}^3(\phi)$ with respect to ϕ produces a half-ball $\bar{B}^4_+$ in $\mathbb{R}^4$:

$$\int_0^1 \chi(\bar{B}^3(\phi))\, d\phi = \sqrt{1 - r^2},$$

where $r = \sqrt{x_1^2 + x_2^2 + x_3^2}$, for $r \leq 1$.
The equation $x_4 = \sqrt{1 - x_1^2 - x_2^2 - x_3^2}$ precisely defines the *upper half-sphere* S^3_+ in $\mathbb{R}^4$, whose interior is the half-ball $\bar{B}^4_+$.
The temporal parameter ϕ thus becomes the *fourth spatial coordinate* x_4 in $\mathbb{R}^4$.

Proof sketch. For a fixed point $\vec{x}$ with $r = \|\vec{x}\| \leq 1$: $\vec{x} \in \bar{B}^3(\phi) \Leftrightarrow \phi \leq \sqrt{1 - r^2}$. Therefore $\int_0^1 \chi\, d\phi = \sqrt{1 - r^2}$. This function is the "height" x_4 of the half-sphere above (x_1, x_2, x_3).

Hierarchy of emergent dimensions

The grain program presents a hierarchy of dimensions, each generated by a geometric operation on the previous one.

Dimension	Construction	Source
1	Linear deployment $\widetilde{\mathbb{R}}$	Volume I
2	Working plane (O, Δ, C_1), Δ_∞	Volume II
3	Stratal space $\bar{B}^3$ by intrinsic rotation	This talk
4	Spacetime $\bar{B}^4_+$ by temporal integration	This talk

Operations generating each dimension.

- Linear deployment (Volume I).
- Projective compactification (Volume II).
- Rotation around Δ_∞.
- Temporal integration of $\bar{B}^3(\phi)$.

Conceptual reading. The progression is geometrically structured: each new dimension emerges from a specific operation, without arbitrary choices.

The spacetime boundary

Proposition (Spacetime boundary)

The stratal spacetime $\bar{B}^4_+$ admits as boundary:

$$\partial \bar{B}^4_+ = S^3_+ \cup \text{equatorial disk}.$$

At the equatorial slice $\phi = 0$, the boundary contains the unit ball. The non-trivial topological boundary is the 3-sphere S^3.
This 3-sphere is the *topological horizon* of stratal spacetime: the limiting structure reached by moving indefinitely away from the origin.

Status of S^3.

- All points of the cosmological universe are contained in its interior.
- S^3 marks the boundary beyond which spacetime itself no longer exists.

Reading. A stratal reading of the relativistic concept of cosmological horizon, but reduced to a precise and finite geometric structure (compact 3-sphere).

The trace of Δ_∞ in S^3

Proposition (Trace of Δ_∞)

The line at infinity Δ_∞ of the 2D stratal plane (Volume II) admits, in the 4D cosmological spacetime, a *precise geometric trace* in the boundary S^3: it extends to a *great circle of* S^3.
This extension is not a redefinition of Δ_∞ — which remains fundamentally a 1D structure — but a *natural extension* via temporal symmetry, articulating the matter/antimatter duality of the program.

Construction of the great circle.

- Trace of Δ_∞ in the slice $\phi = 0$: two antipodal points on the equatorial unit sphere.
- Trace in the mirror slice $\bar{\phi} = -1$ (corresponding to $\bar{\Gamma}$): two symmetric antipodal points.
- The four points, joined by the flows Γ and $\bar{\Gamma}$, form a *great circle of* S^3.

Articulation with the matter/antimatter conjecture

The geometric support. The great circle of S^3 provides a *precise geometric support* for the matter/antimatter conjecture of the document on Planck's constant.

Reading.

- The universal flow Γ corresponds to matter propagation.
- The mirror flow $\bar{\Gamma}$ corresponds to antimatter.
- Annihilation corresponds to their encounter on Δ.

In the 4D cosmological context, this encounter takes place on the great circle of S^3 which is the extended trace of Δ_∞.

Three coherent roles of Δ_∞.

- In Volume II: line at infinity of the projective stratal plane.
- In the cosmological construction: axis of intrinsic rotation.
- In the boundary S^3: great circle of matter/antimatter encounter.

Δ_∞ remains a single structural object, acquiring naturally a geometric trace in each emergent dimension.

Position of the problem

The construction so far provides a *purely geometric* spacetime structure (ball $\bar{B}^4$). It does not yet contain matter, nor its effect on geometry.

Conjecture (Stratal feedback of matter)

Matter, in the framework of the grain program, acts as a *local stratification factor* on spacetime $\bar{B}^4$, by analogy with the functional stratification theorem.
More precisely, at each grain of spacetime, the presence of matter modifies the local homothety ratio λ, which translates into a deformation of the ambient stratal metric.
This conjecture is the stratal analog of Einstein's equations of general relativity.

What remains to be constructed

To transform the conjecture into a theorem, one would need:

1. Define matter as an object of the grain program. Several paths exist (stratal excitations, grid defects, non-trivial topological structures), but none is yet established.

2. Construct a stratal energy-momentum tensor encoding the matter distribution.

3. Establish stratal equations analogous to Einstein's, relating the curvature of the stratal metric to matter distribution.

4. Verify consistency with the observational predictions of general relativity:

- Gravitational deflection of light.
- Gravitational waves.
- Friedmann-Lemaître cosmology.

Status. Each of these points is a research program in itself.

What is solid

The present talk establishes, in a coherent framework with the grain program:

Geometric construction.

- Elevation of the 2D stratal plane to 3D stratal space by intrinsic rotation around Δ_∞.
- Identification of null-collar tori Γ^2 and encapsulating spheres S^2 generated by this rotation.
- Densification of the structure at levels $-kn_\infty$ with $k \geq 1$, yielding stratal space $\bar{B}^3$.
- Rigorous passage 3D $\to$ 4D by temporal integration.

Topological structure.

- Stratal spacetime $\bar{B}^4_+$ with boundary S^3.
- Trace of Δ_∞ as a great circle in S^3.
- Articulation with the matter/antimatter conjecture.

These results form a *coherent geometric framework* for stratified spacetime.

What is conjectural

Several aspects remain to be deepened, in distinct documents:

Matter and dynamics.

- Precise identification of *matter* as a stratal object.
- *Dynamical equations* (temporal evolution, waves, propagation).
- Articulation with general relativity (stratal Einstein equations).

Articulation with stratal quantum mechanics.

- Quantum field theory on stratified spacetime.
- Status of measurement and irreversibility.

Cosmology.

- Comparison with relativistic cosmological models.
- Potential stratal corrections (cosmic microwave background, Hubble expansion).

The next slide raises one further open question, currently under personal work: the *informational role of the boundary* S^3.

Open question: the informational role of S^3

An open conjecture, currently under personal work.

The boundary $S^3 = \partial \bar{B}^4_+$, identified as the topological horizon of stratal spacetime, raises a structural question: *could this boundary play an informational role?*

The conjectural mechanism: refactorization. A grain in the corporeal world $\bar{B}^4$ admits multiple equivalent factorizations indexed by a parameter j:

$$f_j = \left(2\pi \cdot 2^{jn_\infty},\ 2^{kn_\infty},\ \frac{2\pi}{2^{(k-j)n_\infty}} \right).$$

By varying j, the grain deploys progressively onto the great circle of S^3 (trace of Δ_∞).

Possible reading. The boundary S^3 could host a *world of meaning*, where information from the corporeal world $\bar{B}^4$ is transferred and treated by the refactorization mechanism.

Status. This conjecture goes beyond the strictly mathematical framework of the present talk. It is consigned as a *working direction*, in a separate working document currently being elaborated.

Concluding thoughts

From the working plane to a stratal spacetime.

The grain program admits a natural cosmological extension by two geometric operations:

- Intrinsic rotation around Δ_∞ (2D $\to$ 3D).
- Temporal integration of the evolving ball (3D $\to$ 4D).

The resulting structure ($\bar{B}^4_+$ with boundary S^3) is geometrically well-defined. The trace of Δ_∞ as a great circle of S^3 provides a precise geometric support for the matter/antimatter conjecture.

What remains open.

- The dynamics (matter feedback as a stratal analog of Einstein's equations).
- The informational role of the boundary S^3 (separate working document).

Epistemological stance. The geometric framework is solid; the dynamics and the informational role are conjectural and explicitly marked as such. The program offers *a structured perspective on cosmology*, not a complete derivation of relativistic or quantum gravity.

Thank you.

Questions?

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