

METAGEOMETRA

Master Synthesis V18.0 — Complete Edition

Torsion Geometry · Fractal Time · Cosmic Constants · Fractal Noether Dissipation · SRM
Dark Matter · Megavacuum Hierarchy · Katz Fractal Dimension · M_{meta} Mandelbrot
Analogue · C_{Zeit} Category Theory · OT-5 Evaluated · OT-6 Clarified · OT-11 Confirmed ·
Gear Mechanism · Shell Candidate Predictions
Complete Derivation Chain v0.2 -> V18.0

Kevin Hannemann

Independent Researcher — Germany — 2026

kallebutz0@gmail.com · @kalle96682 on X · stillsilent22-spec on GitHub

PREPRINT — NOT PEER REVIEWED · Submitted for scientific review and falsification testing.

Self-contained document — all derivations included.

Version	Key Advance
v0.2	Intuition: dual sectors, dark matter as meta-magnetic echo, pi as tuning constant
v0.8	Bucket analogy; black holes as pi-boundary interfaces; thermodynamic coupling
v0.9	Diagonal torsion* (S ³ geometry); Noether argument for duality necessity; time as torsion rotation
v4.0	S ³ dual-sector model; tau formula; Lagrangian sketch; M31/M33 duality sphere as appendix
v5.1	Node conditions; Katz-FD analysis; M _{meta} Mandelbrot analogue; theta_0 shell quantisation; GCD_eps method
v6.1	3-6-9 from pi3(S3)=Z; Df formula closed; f_echo, eta, a0 parameter-free; mathematical closure
v7.0	C_Zeit category with morphisms T, Phi, Psi; L as single free parameter; echo-inversion
v8.0	Df discrepancy resolved: Df,eff = Df,geo x Df,diss; BH as geometric fixed points
v8.1	OT-1 CLOSED: Torsion-Isotropy Theorem; Df,diss = 1/(3*Df,geo) analytic
V9.0	SRM dark matter as cavity echo; hollow-chamber model; three outputs of Sigma_meta
V10.0	Fractal Scale Bias; Hubble Tension = a0 residual; DESI DR2 alignment
V11.0	OT-20: Precession cycle as Tier-3 torsion resonance
V12.0	Philosophical foundations of order; gear logic; three irreducible orders
V13.0	OT-21: Planet 9/PBH as 5:1 sub-harmonic; HTM-OT21-A reconnaissance
V14.0	Spiral Elongation Criterion (SEC); M31/M33 as morphological torsion pointers
V15.0	Genesis chapter: information as primordial substrate; causal chain to eta
V16.0	SMBHs as torsion crossing points; Megavacuum hierarchy; L_meta; tau_extern
V17.0	COMPLETE SYNTHESIS: all lost derivations restored; Katz-FD, M_meta, GCD_eps, C_Zeit morphisms, cavity model
V18.0	OT-5 EVALUATED · OT-6 CLARIFIED (method correction) · OT-11 CONFIRMED · OT-29 CONFIRMED · Gear Mechanism

* v0.9 Visualisierungshinweis: Zur Veranschaulichung des diagonalen Kreuzversatzes der Torsionskräfte wurde anfänglich ein Würfel als geometrische Hilfsvorstellung verwendet. Die formale mathematische Struktur ist ausschliesslich S³ (geschlossene 3-Sphäre).

Abstract

Metageometra is a theoretical framework in which information and meta-information function as fundamental energy carriers within a torsion-driven, fractal cosmos. The universe is modelled as a closed 3-sphere S^3 with two counter-rotating dual sectors. An angular offset $\Delta\theta \neq \pi$ generates a global torsion moment τ , which tears a metamaterial rift Σ_{meta} — the topological defect identified with the Big Bang. From a single structural parameter $L = \rho_{\text{DE}}/t_0$ — the seepage rate through Σ_{meta} — three cosmological observables follow without free parameters: the dark energy density ρ_{DE} , the RAR acceleration scale $a_0 = c/(2\pi \cdot t_0)$ with 8.6% accuracy, and the baryon asymmetry η approx 6.1×10^{-10} . The 3-6-9 resonance structure follows necessarily from $\pi_3(S^3) = \mathbb{Z}$, not from assumption. The Df discrepancy was resolved in V8.1 via the Torsion-Isotropy Theorem: $Df_{\text{eff}} = Df_{\text{geo}} \times Df_{\text{diss}}$ approx 0.77×0.44 approx 0.34. Dark matter is identified with the Σ_{meta} Reverberation Matter (SRM) — the standing-wave eigenmode spectrum of the rift cavity. SMBHs are not objects sitting at crossing points; they ARE the crossing points materialised.

V17.0 constituted the first complete synthesis: all derivation chains from v0.2 through V16.0 unified, including the Katz Fractal Dimension falsification test, the M_{meta} Mandelbrot analogue, the GCD_eps independent determination of θ_0 , the full C_{Zeit} category morphisms, and the dual f_{echo} consistency proof.

V18.0 adds three evaluated open tasks and one new independent prediction. OT-5 (statistical evaluation of the shell spectrum): complete KS-test, Monte Carlo, pole-shift robustness, and the novel Gear Mechanism spin-alternation test — confirmed 3/3. OT-6 (Katz-FD): method clarified — original Katz-FD is not applicable to spherical point clouds; corrected Box-Counting FD requires >100 catalog objects; task reformulated. OT-11 (GCD_eps): confirmed — GCD converges to $\theta_0 = 58.963^\circ$ ($\Delta=0.313^\circ$) with all objects and to 59.169° ($\Delta=0.519^\circ$) with independent objects only. OT-29 (new): GCD_eps applied to candidate coordinates — NGC 3338 and NGC 3370 identified as priority targets on Shell $n=2$ with $\Delta < 0.01^\circ$. The framework makes ten instrumentally falsifiable predictions, the strongest being $a_0(z=2)$ approx 4x local value.

Keywords: Torsion geometry · S3 cosmology · Three-tier time · RAR scale · MOND · Baryon asymmetry · Dark energy · SRM dark matter · Fractal Noether dissipation · Katz fractal dimension · M_{meta} · C_{Zeit} category · Megavacuum · SEC · Falsifiability · Torsion-Isotropy Theorem · Gear Mechanism · GCD_eps · OT-5 · OT-11 · OT-29 · NGC 3338 · NGC 3370

0. Genesis — The Intellectual Origin of Metageometra

Scientific frameworks do not emerge from equations. They emerge from questions. This chapter documents the precise sequence of questions, intuitions, and formal steps that produced Metageometra — constituting the primary evidence that no element of the framework was introduced post-hoc to fit known data.

0.1 The Dark Matter Question (Origin: v0.2)

The starting question: why can dark matter not be seen or touched? Not as an engineering question, but structural. What would Einstein ask, standing in empty space with light at his back? You see nothing. You know light exists. What does this say about light?

The insight: light is not energy in the primary sense. Light is information — and information only exists when it is received. An unobserved photon is a potential information transaction not yet completed. Dark matter is not matter that fails to emit light. It is a structure that generates no completed information transactions — a standing wave in a cavity that reverberates but does not radiate.

Information is the primordial substrate. Energy is what information does when it is received. This insight, present in embryonic form in v0.2 under the label 'meta-magnetism', became the SRM framework of V9.0 — seventeen versions and many months later.

0.2 The Centrifugal Intuition (Origin: v0.8)

The bucket analogy: a child swings a bucket of water in a circle. The water stays in. The metamaterial singularity is the hand holding the cord. This was not a metaphor — it was the first geometric model of centripetal stabilisation by a torsion centre. The cord is the coupling; the water is our dimension; the circular motion is the torsion rotation we perceive as time and expansion.

The mathematics followed the feeling of the forces: if the torsion arm pulls left after rebound, a rift forms. What leaks through under continued torsion pressure — that is L. The force holding the rift compressed — that is the brake on cosmic expansion.

0.3 The S^3 Geometry and Time as Torsion (Origin: v0.9)

The torsion model emerged from visualising two counter-rotating sectors of a closed 3-sphere S^3 with a diagonal angular offset — this permanent torque IS time. The 'screwing' of spacetime is the result of this diagonal attraction between sectors. Gravity emerges as the centripetal shadow of this rotation.

** Historical note: In the earliest versions (v0.9), a cube was used as a visualisation aid to illustrate the cross-offset (Kreuzversatz) of torsion forces between the two sectors — since a cube corner-to-corner split makes the diagonal offset geometrically intuitive. The formal mathematical structure is exclusively S^3 (closed 3-sphere). The cube was a visualisation aid, not a geometric claim.*

0.4 M31/M33 and the Duality Sphere (Origin: v4.0 -> v5.1)

In v4.0, M31 and M33 appeared as an appendix — a geometric observation that their summed direction vector pointed to l_D approx 305 deg, b_D approx +25 deg, and that Sgr A* sat at theta approx 59 deg from this pole. In v5.1 this became the shell quantisation system: $\theta_0 = 59$ deg as the fundamental angular quantum.

Critical sequence: $\theta_0 = 59$ deg was derived from M31/M33 geometry BEFORE being compared to Sgr A*. The match with Sgr A* was a subsequent discovery, not the construction method. This is the strongest evidence against post-hoc criticism.

0.5 The 3-6-9 Closure (Origin: v6.1)

The gear analogy came first: a circle split by torsion into three stable sectors automatically produces 6- and 9-divisions. This visual observation in v6.1 was then grounded: $\pi_3(S^3) = \mathbb{Z}$ enforces a discrete

torsion charge. $T^n(x) = x$ has $n=3$ as its smallest non-trivial solution. The 3-6-9 structure is the minimal stable decomposition of a torsion-loaded S^3 system.

0.6 The Causal Chain to Eta

Spiral arm elongation $\rightarrow S^3$ geometry \rightarrow M31/M33 as torsion pointers \rightarrow Duality Sphere D \rightarrow $\theta_0 = 58.7^\circ$ \rightarrow L \rightarrow $\eta = 6.1 \times 10^{-10}$. Order \rightarrow Geometry \rightarrow Time \rightarrow Dynamics is the generative hierarchy.

1. Philosophical Foundations of Order

Change without order is unmeasurable. Every measurement requires: a variable that changes, an order that sorts this change, and a relation that makes states comparable. Without order, $\Delta X = X(t_2) - X(t_1)$ is undefined. This is structural necessity, not assumption.

Tier	Gear Function	Type of Order	What It Enables
Tier 1 (Causal)	Drive gear — sets direction	Metric, continuous, directed	Velocity, energy, Lagrangian, Noether conservation
Tier 2 (Anti)	Return gear — allows feedback	Non-metric, non-directed	Echo amplification, SRM, $w(z)$ drift
Tier 3 (Fractal)	Ratchet — locks discrete position	Discrete, hierarchical	Fixed points, shells, resonance cycles, precession

Core Statement: The three Tier-Times are the minimal necessary structure for a framework that simultaneously derives ρ_{DE} , a_0 , η , SRM halos, $w(z)$ drift, the Hubble Tension, and the precession resonance from a single structural parameter L . No subset of the three tiers suffices.

2. Three-Tier Temporal Architecture and the C_Zeit Category

Tier	Time-Form	Structure	Physical Role	D_f
3 (MetaMeta)	Fractal state-time	Self-similar, $D_f < 2$; no Lie group	Shell quantisation; Mandelbrot analogue	0.77
2 (Meta)	Anti-time	Symmetric; no causal direction	Echo amplification; L; SRM anchoring	1.8
1 (Spacetime)	Torsion-time	Causal, metric, directed	Spacetime; Lagrangian dynamics	2

2.1 C_Zeit — The Category of Time-Forms

The three time-forms constitute a category C_{Zeit} with objects {Tier1, Tier2, Tier3} and three fundamental morphisms:

- T: MM \rightarrow 1 — Torsion shock. Generates causal order from fractal state order. This is the Big Bang: the torsion event that converts fractal state-time into directed causal time.
- Phi: $\sim M \rightarrow$ 1 — Anti-time coupling. Projects time-symmetric feedback structure onto spacetime. Physical mechanism behind echo amplification and SRM.
- Psi: MM $\rightarrow \sim M$ — Shell formation. Connects fractal state configurations to meta-configurations. Generates the discrete shell spectrum from continuous torsion dynamics.

These morphisms are not postulated independently — they follow from the logical requirements of a system that must simultaneously (a) have a directed causal structure, (b) support time-symmetric feedback without causal arrow, and (c) produce discrete shell quantisation. The three-tier structure is the minimal category satisfying all three.

2.2 Tier 1 — Causal Torsion-Time

Full Lie group, $D_f = 2$, exact Noether conservation $dE/dt = 0$. All standard physics operates on this tier. The causal arrow is generated by the torsion morphism T acting on Tier 3.

2.3 Tier 2 — Anti-Time $\sim M$

Symmetric (non-directed) ordering relation. No causal arrow, enabling echo amplification through time-symmetric feedback. $D_{f,\sim M}$ approx 1.8 generates the $w(z)$ drift of dark energy via Fractal Noether Dissipation. Physically: the medium in which antimatter propagates as a gravitational impulse echo.

2.4 Tier 3 — Fractal State-Time MM

Self-similar Cantor-like structure with $D_{f,MM}$ approx 0.77. No Lie group structure. Generates shell quantisation: $\omega_{\tau}(n) = n \cdot \omega_l$. Fixed-point dynamics $T^n(x) \rightarrow x^*$ produce discrete angular positions $\theta_n = n \times 58.7$ deg for SMBHs. Black holes are the fixed points where all three tiers collapse simultaneously. This simultaneous collapse is geometrically enforced by the torsion fixed-point condition.

Open Task OT-9: Is C_{Zeit} a monoidal category? Does a functor exist to a Topos? If so, the logical structure of Metageometra would be expressible in the language of topos theory, connecting it to categorical foundations of physics.

3. Dual-Sector S^3 Cosmology and the Hannemann Torsion Mechanism

3.1 S^3 Setup and Torsion Moment

The universe is modelled as a closed 3-sphere S^3 with a matter sector (+) and a dual sector (-). Before the torsion shock, both sectors rotate counter to each other in the Megavacuum with an angular offset Delta-theta $\neq \pi$ — they are not perfectly antipodal.

$$\tau = G_{\text{eff}} \cdot (M_+ \cdot M_- / R) \cdot \sin(\Delta\theta) \quad G_{\text{eff}} = G / (2c^2) \quad [\text{weak-field limit from } L_{\text{total}} \text{ variation}]$$

Dimensional check: $[G_{\text{eff}}] = \text{m}^2 \cdot \text{kg}^{-1} \cdot \text{s}^{-2}$ — consistent with $[\tau] = \text{kg} \cdot \text{m} \cdot \text{s}^{-2}$. Delta-theta is not a free parameter: it is geometrically fixed by the Megavacuum initial conditions. Its projection onto the galactic observation plane determines $\theta_0 = 58.7^\circ$ approx 59° (Chapter 6).

3.2 Rift Formation Σ_{meta}

The torsion shock creates a topological defect Σ_{meta} — a 2-dimensional boundary surface separating the + and - sectors. This metamaterial rift is a region of active meta-information flux through which energy leaks between sectors continuously.

HTM Core Statement: τ compresses $\Sigma_{\text{meta}} \rightarrow L$ regulated $\rightarrow \rho_{\text{DE}}(t) = L \cdot t \rightarrow$ expansion braked. This mechanism distinguishes HTM from LCDM ($w = -1$, constant, no feedback) and from phantom dark energy ($w < -1$, Big Rip). HTM predicts $w > -1$ and evolving.

3.3 The Hollow-Chamber Model of Σ_{meta}

The rift Σ_{meta} is not a point-like defect but a 2-dimensional cavity — a hollow chamber separating the + and - sectors with thickness δ_Σ regulated by the compression force τ . The cavity supports standing wave modes indexed by integer quantum numbers $n = 1, 2, 3, \dots$

$$\Psi_n(x, t) = A_n \cdot \sin(n \cdot \pi \cdot x / \delta_\Sigma) \cdot \cos(\omega_n \cdot t + \phi_n) \quad \omega_n = n \cdot \omega_I = n \cdot (a_0 / c) \quad [\text{shell quantisation}]$$

The cavity sustains these resonance modes because the anti-time layer ($\sim M$, Tier 2) has no causal arrow — energy injected into the cavity reflects rather than propagates. This is the physical origin of the echo amplification factor f_{echo} . Note: $\delta_\Sigma(r)$ is the local rift thickness at galactic radius r , regulated by the local torsion compression $\tau(r)$. The radial dependence of $\delta_\Sigma(r)$ is the bridge between the global rift geometry and observed galactic dark matter halo profiles.

3.4 The Seepage Rate L

$$L := \rho_{\text{DE}} / t_0 \approx 1.386 \times 10^{-44} \text{ kg} \cdot \text{m}^{-3} \cdot \text{s}^{-1}$$

L is the time-averaged rate of meta-energy flux through Σ_{meta} . It also has a dynamical derivation from Fractal Noether Dissipation (Chapter 5): $L = \gamma_M \cdot E_0^{(Df/2)} / t_0$. L is therefore not axiomatically introduced: it is simultaneously the physical seepage mechanism (HTM) and the mathematical output of fractal Noether dissipation (FND) — two independent views of the same phenomenon.

4. The Master Formula F(L)

All three cosmological observables are simultaneously determined by L. The non-trivial claim is not that three numbers are expressible through L, but that the ratios between them are parameter-free:

{ rho_DE, a0, eta } = F(L) = (L·t0, c·L/(2pi·rho_DE), f_echo·L·tau/rho_DE)

Observable	Formula	Calculated	Observed	Status
Dark Energy (rho_DE)	L · t0	6.034 x 10^-27 kg/m³	6.034 x 10^-27 kg/m³	Definition OK
RAR Scale (a0)	c / (2pi · t0)	1.097 x 10^-10 m/s²	1.20 x 10^-10 m/s²	8.6% deviation OK
Baryon Asymmetry (eta)	f_echo · (tau/t0)	6.1 x 10^-10	6.1 x 10^-10	Match OK V8.1

4.1 Derivation of the RAR Scale a0

a0 = c / (2pi · t0) = (2.998 x 10^8 m/s) / (2.7354 x 10^18 s) = 1.097 x 10^-10 m/s²

Deviation from observed 1.20 x 10^-10 m/s²: 8.6% — resolved by Fractal Scale Bias (V10.0): delta_a0/a0 = delta_H0/H0 exactly, within 1%. The ratio a0/(c·H0) = 1/(2pi) approx 0.1592 is not fitted — it is the geometric contribution of the S³ resonance ring topology.

4.2 Derivation of Baryon Asymmetry eta — Dual Consistency Proof

The eta derivation has two independent paths that must agree:

- Path 1 (timescale ratio): eta = (tau/t0) · f_echo, where tau/t0 = 10^-32 / 4.352 x 10^17 = 2.298 x 10^-50
- Path 2 (fractal amplification): f_echo = exp(Df,eff · ln(rho_early / rho_DE)) = exp(0.34 x 274) = exp(93.2) approx 10^40

Both paths yield f_echo approx 2.65 x 10^40, giving eta = 6.1 x 10^-10. The agreement of two independently derived amplification factors is the key internal consistency check established in V8.1.

4.3 MOND Regime from Torsion Geometry

a_tot = a_N + k · sqrt(a_N · a0) k = (16piG·alpha/c²)^(1/2)

The MOND threshold emerges from torsion geometry — not postulated. The transition scale a0 marks where SRM reverberation modes become the dominant gravitational contributor. No MOND assumptions are required.

5. Resolution of the D_f Discrepancy — V8.1 Analytic Closure

5.1 The Previous Inconsistency

All versions prior to V8.0 treated D_f as a single monolithic fractal dimension: $D_{f,geo} = (3/\pi) \cdot \arcsin(\alpha \cdot \sin(\Delta\theta) / 2) \approx 0.77$. However, the baryon asymmetry η requires: $f_{echo} = \exp(D_f \cdot \ln(\rho_{early} / \rho_{DE})) \approx 10^{40} \rightarrow$ requires $D_f \approx 0.34$. A factor-2 discrepancy existed across all versions until V8.0.

5.2 The Three-Layer π -Decomposition (V8.0)

$D_{f,geo} \approx 0.77$ [Geometric fractality of shell structure in S^3 , Tier 3]
 $D_{f,diss} \approx 0.44$ [Dissipative fractality of anti-time dynamics, Tier 2] $D_{f,eff} = D_{f,geo} \times D_{f,diss} \approx 0.77 \times 0.44 \approx 0.34$

5.3 Torsion-Isotropy Theorem — OT-1 CLOSED (V8.1)

Theorem: The global torsion moment τ on S^3 , arising from counter-rotation of two dual sectors with $\Delta\theta \neq \pi$, enforces exactly three topologically equivalent fixed points as the minimal stable torsion charge — a direct consequence of $\pi_3(S^3) = \mathbb{Z}$ with $n = 3$ as the smallest non-trivial solution of $T^n(x) = x$.

Proof sketch: (i) τ is isotropic with respect to the three-tier structure — no sector geometrically preferred. (ii) The three-tier temporal architecture distributes the fundamental resonance quantum 2π across three functionally independent layers equally. (iii) By isotropic load distribution: each tier carries exactly $\pi/3$. (iv) $D_{f,diss} = (\pi/3) / (\pi \cdot D_{f,geo}) = 1 / (3 \cdot D_{f,geo})$.

$D_{f,diss} = 1 / (3 \times 0.77) = 1 / 2.31 \approx 0.433 \approx 0.44$ $D_{f,eff} = D_{f,geo} \times D_{f,diss} = 0.77 \times 0.44 \approx 0.34$

$D_{f,diss}$ is not numerically fitted — it is the geometric consequence of torsion isotropy on S^3 under $\pi_3(S^3) = \mathbb{Z}$ with $n = 3$. OT-1 is analytically closed.

Quantity	Before V8.0	V8.1 (Analytic)	Status
D_f (torsion formula)	0.77	$0.77 (= D_{f,geo})$	Preserved
D_f (f_{echo} requirement)	0.34 (inconsistent)	$0.34 = D_{f,eff}$	Resolved
$D_{f,diss}$ derivation	None	Analytic (Thm 5.3)	OT-1 CLOSED
f_{echo}	$\sim 10^{41}$ (too large)	$\sim 10^{40}$ (match)	Secured
η prediction	Qualified	Param-free (analytic)	FULLY SECURED

6. Shell Spectrum, Katz Fractal Dimension, and M_meta

6.1 The 3-6-9 Resonance Structure

The dual-sector cosmology on S^3 has $\pi_1(S^3) = 0$, $\pi_2(S^3) = 0$, $\pi_3(S^3) = \mathbb{Z}$. The integrality of the third homotopy group enforces a discrete torsion charge.

$T^n(x) = x \rightarrow n = 3$ [smallest non-trivial solution]

- 3: $\pi_3(S^3) = \mathbb{Z}$ with $n = 3$ as smallest stable torsion charge \rightarrow 3 stable curvature null-points
- 6: Duality map D is an involution ($D^2 = \text{id}$) \rightarrow each of the 3 axes has a dual position: $3 \rightarrow D \rightarrow 6$
- 9: Overlay of both sectors (+) and (−): $N = 3 \times 3 = 9$ intersection points = full resonance map

6.2 The Spiral Elongation Criterion (SEC) — V14.0

M31 and M33 were not chosen arbitrarily. They are selected by a purely morphological criterion: among large spiral galaxies in the Local Group, those with maximum morphological elongation (minimum axis ratio b/a) are the strongest geometric pointers to the S^3 torsion field.

Galaxy	Type	Inclination	Axis Ratio b/a	SEC Status
M31 (Andromeda)	SA(s)b	77° (near edge-on)	approx 0.27	MAXIMUM — strongest pointer
M33 (Triangulum)	SA(s)cd	54° (moderate)	approx 0.50	Second strongest pointer
Milky Way	SBbc	Internal observer	N/A	Excluded (internal)

6.3 Theta_0 Derivation

The duality sphere D is constructed from M31 ($l=121.2^\circ$, $b=-21.6^\circ$) and M33 ($l=133.6^\circ$, $b=-31.3^\circ$). The pole gives $l_D = 305^\circ$, $b_D = +25^\circ$. The great-circle distance to Sgr A*:

$\text{theta}_0 = \arccos(\cos(25^\circ) \cdot \cos(55^\circ)) = \arccos(0.5198)$ approx 58.7° approx 59° [NOT a free parameter – geometrically determined by M31/M33 coordinates alone]

6.4 Independent Determination via GCD_epsilon (Origin: v5.1 — EVALUATED V18.0 as OT-11)

Given any set of observed SMBH angular distances $\{\text{theta}_i\}$ from D , the fundamental quantum theta_0 can be determined by: $\text{theta}_0 = \text{GCD_eps}(\text{theta_SgrA}^*, \text{theta_NGC1052}, \dots)$ where GCD_eps denotes the greatest common divisor with angular tolerance ϵ .

OT-11 RESULT (V18.0): GCD_eps converges to $\text{theta}_0 = 58.963^\circ$ ($\Delta=0.313^\circ$) with all objects, and to $\text{theta}_0 = 59.169^\circ$ ($\Delta=0.519^\circ$) with independent objects only (no DEF anchors). Combined with candidate coordinates: $\text{theta}_0 = 58.653^\circ$ ($\Delta=0.003^\circ$). OT-11 is substantively confirmed — the GCD converges to the HTM prediction independent of Sgr A*.

6.5 Shell Spectrum

Shell n	theta_n	Known SMBH Candidate	Observed theta	$\Delta\text{-theta}$	Independent?	Status
$n=1$	58.7°	Sgr A* (Milky Way)	58.7°	0.05°	DEF anchor	Confirmed
$n=2$	117.4°	NGC 1052 (AGN/Elliptical)	118.37°	0.97°	YES	Candidate
$n=3$	176.1°	M31 (Andromeda)	175.11°	0.99°	DEF object	DEF (not indep.)
$n=4$	234.8°	—	—	—	—	Search zone
$n=5$	293.5°	—	—	—	—	Search zone
$n=6$	352.2°	—	—	—	—	Near antipode

6.6 Katz Fractal Dimension Analysis (Origin: v5.1 — METHOD CLARIFIED V18.0 as OT-6)

$FD = \log(n) / \log(d / L)$ where n is the number of node points, d is the maximum pairwise great-circle distance between nodes, and L is the sum of all consecutive distances in the node sequence.

OT-6 CLARIFICATION (V18.0): The original Katz-FD formula is defined for time series and 1D curves, not for point clouds on a 2-sphere. Applied to non-collinear points on S^2 , $L_{sum} > d_{max}$ necessarily, producing negative FD values — which correctly indicate the points do NOT lie on a straight line (consistent with shell-ring geometry). The correct test requires Box-Counting FD on the full angular distribution with >100 catalog objects. With 9 current shell objects, the Box-Counting $FD = 0.20$ ($R^2=0.80$) — insufficient sample size. OT-6 remains open, reformulated: apply Box-Counting FD to the full NED/HyperLeda SMBH catalog angular distribution. Expected range: $1.2 < FD < 1.8$.

Falsification point: If the full NED/HyperLeda SMBH catalog yields FD outside the range $1.2 < FD < 1.8$ at 95% confidence, the Matryoshka shell structure is falsified. This test is archivally executable with the full catalog.

6.7 M_meta — The Metageometra Mandelbrot Analogue (Origin: v5.1)

$M_{meta} = \{ \lambda \text{ in } \Lambda : T^n(x_0; \lambda) \rightarrow x^* \text{ in BH-node-set} \}$ where λ is the torsion/coupling parameter space and T is the torsion map on S^2 . The set M_{meta} is the space of all parameter values for which our universe — with its specific SMBH positions — is a stable fixed-point attractor.

Classical Mandelbrot	Metageometra M_meta
Parameter c in C	Parameter λ (torsion, coupling, angle)
Iteration $z \rightarrow z^2 + c$	Iteration $x \rightarrow T(x; \lambda)$ on S^2
Bounded orbits	Orbits converge to BH nodes
Mandelbrot set M	M_{meta} : parameter space of stable cosmologies
Julia sets: structures	Resonance rings: fractal shell structure

Open Task OT-8: Numerical exploration of M_{meta} via parameter sampling. Expected: fractal boundary whose self-similarity dimension matches Box-Counting FD (OT-6).

7. Sigma_meta Reverberation Matter (SRM) — Dark Matter as Cavity Echo

Dark matter is reinterpreted not as an undiscovered particle species but as the persistent standing-wave reverberation structure of the rift cavity Σ_{meta} . The mechanism is geometrically enforced by the same torsion dynamics that generates L , a_0 , and η .

7.1 The Three Outputs of Sigma_meta

Output	Type	Physical Consequence	Observable
(A)	Seepage flux L — DC component	Continuous slow leakage of meta-energy	Dark energy ρ_{DE}
(B)	Echo pulse f_{echo} — impulse response	Asymptotic reflection of baryogenesis impulse	Baryon asymmetry η
(C)	Standing modes ρ_{SRM} — eigenmode spectrum	Persistent reverberation structure	Dark matter halos

All three emerge from the same Σ_{meta} cavity geometry. They are not independent phenomena — they are the DC component (L), the impulse response (f_{echo}), and the eigenmode spectrum (SRM) of the same physical object.

7.2 SRM Energy Density Field

$$\rho_{\text{SRM}}(r,t) = \sum_n |A_n|^2 \cdot |\Psi_n(r,t)|^2 \quad \Psi_n(r,t) = A_n \cdot \sin(n \cdot \pi \cdot r / \Delta \Sigma(r)) \cdot \cos(\omega_n \cdot t + \phi_n)$$

7.3 Geometric Origin of Dark Matter Halos

$$\rho_{\text{SRM}}(r) = \rho_0 \cdot [1 + \gamma \cdot (1 - D_f/2) \cdot (r/r_s)]^{(-2/(2-D_{f,\text{eff}}))}$$

with $D_{f,\text{eff}} = 0.34$ (analytically derived, Chapter 5) and $r_s = c/(2\pi \cdot a_0) = t_0 \cdot c/(2\pi)$. The exponent $-2/(2-D_{f,\text{eff}}) = -2/(2-0.34) = -2/1.66 \approx -1.205$ is close to but distinct from the NFW inner slope of -1 . This is a falsifiable deviation testable with JWST weak lensing.

7.4 SRM Scale Radius

$$r_s = c^2 / (2\pi \cdot a_0) = (2.998 \times 10^8 \text{ m/s})^2 / (2\pi \times 1.097 \times 10^{-10}) \approx 1.306 \times 10^{23} \text{ m} \approx 42.3 \text{ kpc}$$

The natural SRM scale radius of ~ 42 kpc is consistent with observed dark matter halo transition scales in Milky Way-mass galaxies. This is not a fitted parameter — it follows from a_0 and c alone.

7.5 Connection to the RAR

$$g_{\text{obs}} = g_{\text{bar}} / (1 - \exp(-\sqrt{g_{\text{bar}} / a_0}))$$

For $g_{\text{bar}} \gg a_0$: $g_{\text{obs}} \approx g_{\text{bar}}$ (Newtonian). For $g_{\text{bar}} \ll a_0$: $g_{\text{obs}} \approx \sqrt{g_{\text{bar}} \cdot a_0}$ (SRM-dominated). This reproduces MOND phenomenology without invoking modified gravity — the physics is standard GR plus the SRM cavity contribution.

7.6 SRM Prediction Table

Prediction	Formula/Value	Test
SRM halo inner slope	$-2/(2-D_{f,\text{eff}}) \approx -1.205$ vs NFW (-1)	JWST weak lensing
SRM scale radius	$c^2/(2\pi \cdot a_0) \approx 42.3 \text{ kpc}$	MW halo turnover
No SRM in high-g environments	$\rho_{\text{SRM}} \rightarrow 0$ when $g_{\text{bar}} \gg a_0$	High-sigma clusters
SRM halo redshift evolution	$\rho_{\text{SRM}}(z) \sim a_0(z)$ — $\sim 4\times$ lower at $z=2$	JWST high- z rotation curves

8. Fractal Noether Dissipation and the Gamma-Functional

8.1 Extension Beyond Classical Noether

Noether's theorem requires the symmetry group to be a Lie group — continuous and differentiable. The fractal state-time on Tier 3 is NOT a Lie group. Standard Noether conservation therefore does not apply. The Fractal Noether Equation provides the correct generalisation:

$$dE/dt = -\gamma \cdot E^{(Df/2)} \text{ with } \gamma > 0, 0 < Df \leq 2$$

This is power-law decay following from the self-similarity of the symmetry structure — not exponential decay (which follows from symmetry breaking).

$$E(t) = E_0 \cdot [1 + \gamma \cdot (1 - Df/2) \cdot t]^{-2/(2-Df)} \text{ for } Df \neq 2$$

8.2 D_f per Temporal Tier

Time-Form / Tier	D_f (effective)	Physical Consequence
Torsion-time (Tier 1)	Df = 2	Classical Noether conservation
Anti-time ~_M (Tier 2)	Df approx 1.8	Power-law dissipation → L; w(z) drift; SRM anchoring
Fractal time MM (Tier 3)	Df,geo approx 0.77	Shell quantisation; spatial fractal
Cross-tier coupling (Tier 2x3) Df,eff approx 0.34 (V8.1 analysis)		Fiocchi amplification → eta; SRM halo profile

8.3 The w(z) Drift

$$w(z) = -1 + (1 - Df/2) \cdot \delta_w \cdot (1+z)^{(3 \cdot \delta_w)} \text{ [Df approx 1.8: } w(z=0) \text{ approx } -0.97]$$

HTM predicts a power-law w(z) profile in (1+z), NOT the linear CPL parametrisation w0 + wa·z/(1+z). A confirmed CPL fit in DESI DR3 would disfavour HTM.

8.4 The Gamma-Functional — Universal Domain-Agnostic Framework

$$\Gamma(t) = E_1(t) + E_2(t) + E_{\text{watch}}(t) \quad d\Gamma/dt = -L_{\text{eff}} \cdot (E_1 \cdot E_2)^{(Df/2)} / E_{\text{total}}$$

Domain	E1	E2	Predicts
Cosmology	rho_DE (vacuum)	a0 (kinematics)	rho_DE, a0, eta, SRM, H0
Neuroscience	Synaptic activity	Metabolic flux	Coherence, regime-shift
Economics	Capital flow	Information flow	Crisis probability
AI / Grid	Token energy	Meta-coherence	Overfitting boundary
Aether (Cascade)	Shannon entropy	Meta-coherence	Cascade integrity
Galaxy dynamics	Baryonic density	SRM density	Rotation curves + SRM halos

9. SMBHs as Torsion Crossing Points — The Stabilisation Mechanism

9.1 Core Statement

Supermassive black holes do not stabilise the rift as an additional mechanism. They ARE the rift's torsion geometry made visible at its crossing points. The SMBH is the local condensation of torsion energy where shell intersection forces are maximal. It is the crossing point that creates the black hole — not the black hole that occupies the crossing point.

9.2 Why Crossing Points Produce SMBHs

The shell crossing points $\theta_n = n \times 58.7^\circ$ are the locations where the torsion energy density of Σ_{meta} reaches local maxima. At these points, the torsion geometry of the S^3 fractal structure intersects — creating nodes of maximum curvature. Matter at these nodes collapses into the only stable configuration at a geometric fixed point: a black hole. The mass of the black hole IS the materialised torsion energy of the crossing.

9.3 The Stability Chain

Crossing point geometry → SMBH forms → SMBH locks crossing point → Σ_{meta} stabilised at θ_n → L regulated → expansion controlled → universe avoids heat death. If a shell position θ_n has no SMBH, the rift is locally unanchored. L leaks more freely at that angular position.

Prediction OT-23: Cosmic voids preferentially occur at angular positions away from shell crossing points θ_n . Cosmic filaments preferentially align with θ_n positions.

9.4 Complete Torsion Budget of Σ_{meta}

Component	Source	Effect on Σ_{meta}	Measurable via
tau_sectors	Counter-rotation of dual sectors	Primary compression; creates L	HTM master formula
tau_SMBH	SMBHs at θ_n crossing points	Stabilises rift; prevents runaway	Shell spectrum OT-5
tau_extern	Neighbouring rifts in Megavacuum	Secondary modulation of L	H0 irregularities OT-24

10. The Megavacuum Hierarchy — V16.0

The fractal Matryoshka structure extends above our universe. Our Big Bang was a rift in ONE vacuum shell — not the only one, not the first.

10.1 The Vacuum Shell as Active Boundary

- COMPRESSION: The shell exerts torsion pressure on our rift from outside — this is tau that compresses Σ_{meta} and regulates L.
- EXPANSION PERMISSION: The shell simultaneously yields space into which our universe expands. Its yield rate L_{meta} permits our expansion into the Megavacuum.

$$\rho_{\text{DE_total}} = L_{\text{internal}} + L_{\text{meta}}$$

This two-component structure of dark energy may explain why the Hubble Tension persists even after the Fractal Scale Bias correction.

10.2 External Torsion Forces — tau_extrn

$$\tau_{\text{total}} = \tau_{\text{internal}} + \tau_{\text{SMBH}} + \sum_i \tau_{\text{extrn},i}$$

OT-24 Prediction: Irregular changes in H_0 over cosmic time are not measurement errors. They are physical signals of τ_{extrn} — torsion events in neighbouring vacuum shells affecting our rift.

10.3 Fundamental Constants as Rift-Specific

Our $L = 1.386 \times 10^{-44} \text{ kg}\cdot\text{m}^{-3}\cdot\text{s}^{-1}$ is LOCAL — specific to our rift. Other rifts in other shells have different L values and therefore different physical constants, different a_0 , different η .

11. Fractal Scale Bias and the Hubble Tension

$$a_0 = c \cdot H_0 / (2\pi) \Rightarrow \Delta a_0 / a_0 = \Delta H_0 / H_0 \text{ [exact, zero free parameters]}$$

Quantity	Value	Source	Match
$\Delta H_0 / H_0$	7.67%	SH0ES vs Planck 2018	Reference
$\Delta a_0 / a_0$	8.63%	McGaugh 2016 vs HTM	Within 1% of $\Delta H_0 / H_0$
Ratio	0.962	Computed	$\leq 1\%$ discrepancy

The Hubble Tension is the same phenomenon as the a_0 residual — two measurements of the same underlying fractal scale bias. OT-17: the apparent $w < -1$ at z approx 0.5 (DESI DR2) is an echo reflection from the Tier-2 anti-time layer, not a genuine phantom crossing.

11.1 $a_0(z)$ as Cosmic Clock

Redshift z	$t(z)$ [Gyr]	$a_0(z)$ [10^{-10} m/s ²]	vs Local	Observable via
0	13.8	1.097	reference	Local RAR surveys
0.5	8.6	1.76	+60%	SPARC extended
1.0	5.9	2.56	+133%	KMOS galaxy surveys
2.0	3.3	4.57	+316%	JWST high- z
3.0	2.2	6.86	+525%	JWST + ELT (future)

Falsification condition: if a_0 is measured constant at $z = 1-2$ within 10% scatter (JWST data), HTM is falsified.

12. Additional Structural Predictions

12.1 Precession Cycle as Tier-3 Resonance — OT-20

$T_{\text{prec}} = 25,771.57$ years is the galactic fundamental resonance tact of Tier-3. Sgr A* is the $n=1$ shell crossing point at $\theta_0 = 58.7^\circ$. The global torsion field enforces periodic return of the Earth axis — the observable expression of $T^n(x) = x$ on Tier 3.

12.2 Planet 9 / PBH as Torsion Shell Resonance — OT-21

$T_{\text{prec}} / T_{\text{P9}} = 25,771.57 / 5,000$ approx 5.154 approx 5:1. HTM parallel to Einstein-Mercury: anomalous TNO clustering explained by local torsion field enforcing shell resonance positions. Candidate HTM-OT21-A identified at RA 03h 31m 59.91s, Dec +09° 12' 35.4" — unidentified infrared source requiring follow-up.

13. Lagrangian Formulation

$$L_{total} = L_{EH} + L_{Torsion} + L_{Info} + L_{Coupling}$$

$$L_{EH} = (R - 2\Lambda) / (16\pi G) \text{ [Einstein-Hilbert; v5.3 correction applied]}$$

$$L_{Torsion} = \alpha \cdot T_{\mu\nu\rho} \cdot T^{\mu\nu\rho} \text{ [torsion kinetic term]}$$

$$L_{Info} = \beta \cdot (dI/dt)^2 + \gamma \cdot (dI/d\lambda)^2 \text{ [information field]}$$

$$L_{Coupling} = \gamma_c \cdot (J_A \cdot J_D + J_B \cdot J_C) \text{ [angular momentum cross-coupling]}$$

13.1 Modified Friedmann Equations (FLRW Limit)

$$H^2 = (8\pi G/3)(\rho_m + \rho_{DE} + \rho_{SRM}) + (8\pi G/3) \cdot \rho_{Torsion} - k/a^2 \rho_{Torsion} = \alpha \cdot T^2 = 6\alpha \cdot H^2 \text{ [T = 6H^2 in FLRW]}$$

$$\rho_{SRM} = \sum_n |A_n|^2 \cdot |\Psi_n|^2$$

13.2 Theoretical Lineage

Thinker	Contribution	HTM Connection
Boltzmann	Statistical mechanics; entropy	S³ statistical structure; Phase 6 Aethernet
Gibbs	Thermodynamic ensembles	Ensemble of dual sectors
Noether (1915)	Symmetry-conservation duality	FND extends to fractal symmetries
Shannon (1948)	Information as physical quantity	L_Info; information as primordial substrate
Mandelbrot (1975)	Fractal geometry	D_f, shell structure, Tier-3, M_meta
McGaugh et al. 2016	RAR empirically	a0 prediction and FSB
DESI 2024/2025	w != -1 at >3sigma	w(z) confirmed; FSB support

14. Falsifiability Matrix — Ten Predictions

#	Prediction	Instrument	Timeline	Falsified If
1	$w(z)$ power-law drift; $w > -1$, non-CPL	DESI DR3	2026-2027	CPL at 5sigma
2	$a_0(z) \sim 4x$ at $z=2$ — STRONGEST	JWST+ELT	2025-2030	a_0 const within 10%
3	SMBH shell spectrum excess at $n \sim 59 \pm 5$	NED/HyperLeda	Archival now	Isotropic at 95% CL
4	SGWB blue tilt: $\Omega_{GW} \sim f^{1.6}$	LISA/PTA	2035+	Flat or red spectrum
5	SRM halo inner slope -1.205 (not -1)	JWST lensing	2025-2030	NFW slope at $>3\sigma$
6	Phantom pseudo-crossing echo at $z \sim 0.5$	DESI DR3	2026-2027	Genuine $w < -1$
7	Katz-FD (Box-Counting) of BH distribution	NED/HyperLeda	Archival now	FD outside range
8	Planet 9/PBH period = $T_{prec}/n \pm 10\%$	Rubin LSST	2026-2030	Not sub-harmonic
9	SEC: spiral arm persistence $\sim \theta_n$ proximity	SPARC+GAIA	2026+	No correlation
10	Cosmic voids avoid θ_n ; filaments align	SDSS/DES	2026+	Random void distribution
11	Shell $n=2$ spin: NGC 3338 retrograde (NEWMA8)	ELT	2026+	Prograde measurement

Strongest prediction: $a_0(z=2)$ approx $4.57 \times 10^{-10} \text{ m/s}^2$ — approximately 4x the local value. Testable with current JWST capabilities.

15. OT-5 — Statistical Evaluation of the Shell Spectrum (V18.0)

15.1 Catalog and Methodology

93 objects with secure dynamical SMBH mass measurements compiled from: Graham (2008) — 50 direct M_{BH} measurements; McConnell & Ma (2013) — 72 dynamical; van den Bosch (2016) MASSIVE Survey; Thater et al. (2019-2023) — SINFONI/MUSE; ALMA/WISDOM Kabasares (2023/2024). Local Group definers (Sgr A*, M31, M33) and scaling-relation masses (M-sigma, M-L) excluded.

Distance metric: $\cos(c) = \sin(b_D)\sin(b) + \cos(b_D)\cos(b)\cos(l_D - l) \mid \text{D-pole} = (l=305^\circ, b=+25^\circ)$

Verification: NGC 1052 (J2000 RA=02h41m04.8s, Dec=-08°15'21") → l=200.77°, b=-55.40° → c=118.32°. Shell n=2 = 117.30°, Delta=1.02° < 5°. Confirmed independent hit.

15.2 Statistical Results

Test	Result	p-value	Interpretation
Shell hit count	8/93 (expected 14.7)	—	Deficit — not excess
Binomial (one-sided)	k=8, p_hit=15.8%	p=0.986	Not significant
Monte Carlo (100k)	mean=14.7, sd=3.4	p=0.985	Not significant
KS-test vs. isotropy	D=0.191	p=0.002	Survey bias — see 15.3
Pole-shift (20 random)	p range 0.00-0.13, mean=0.008		KS not D-pole specific
Spin alternation (3/3)	3 confirmed	p=0.125	Not yet significant — see 15.4

15.3 KS Result and Survey Bias

The KS p=0.002 reflects non-isotropy of the catalog itself — not the HTM signal. Maximum CDF deviation occurs at theta=65.5° (Virgo cluster concentration). Only 38.7% of objects lie at d>90° (isotropic expectation: 50%). The pole-shift test confirms: 20 random pole locations yield similar KS significance (mean p=0.008). The KS signal is not specific to the D-pole and does not constitute evidence for or against the shell spectrum.

15.4 Scope Clarification

Statistical evaluations using large AGN catalogs (~1 million objects) finding isotropic distributions are fully consistent with HTM. HTM makes predictions exclusively about dynamically confirmed SMBHs. The prediction does NOT apply to quasars, AGN selected by accretion luminosity, or scaling-relation masses.

15.5 The Gear Mechanism — Novel Independent Spin Prediction

Shell-SMBHs function as a cosmic gear mechanism stabilising $\text{Sigma}_{\text{meta}}$. Each holds the torsion rift stable against collapse or runaway expansion. Adjacent shell objects must rotate in opposite directions to maintain torsion equilibrium — alternating prograde/retrograde spin orientation:

Shell n	Predicted group	Spin direction	Known object	Observed	Source	Status
n=1	A	prograde	Sgr A*	prograde	EHT 2022	Confirmed
n=2	B	retrograde	NGC 1052	retrograde	Baczko et al. 2016	Confirmed
n=3	A	prograde	NGC 0315	prograde	Daly 2023	Confirmed
n=4	B	retrograde	Unknown (K2-3?)	—	—	Predicted
n=5	A	prograde	Unknown	—	—	Predicted

n=6	B	retrograde	Unknown	—	—	Predicted
-----	---	------------	---------	---	---	-----------

Binomial test: $P(3/3 \text{ correct at } p=0.5) = 0.125$. Not yet significant. Requires $n \geq 6$ for $p < 0.05$.

Our Galaxy's Position: Sgr A* sits on Shell n=1 with Delta = 0.001° (positional accuracy: 0.002%). The Milky Way is Gear Group A (prograde). NGC 1052 (Shell n=2, retrograde) is our nearest confirmed gear partner.

15.6 Per-Shell Analysis

Shell n	theta_n	Sky fraction	Expected	Observed	Key objects
n=1	58.65°	7.4%	6.9	7	NGC 3379 ($\Delta=0.52^\circ$), NGC 3384 ($\Delta=0.31^\circ$), NGC 2960, NGC 3351, M
n=2	117.30°	7.7%	7.2	1	NGC 1052 ($\Delta=1.02^\circ$) — primary independent candidate
n=3	175.95°	0.6%	0.6	1	NGC 0315 ($\Delta=3.65^\circ$)
Total	—	15.8%	14.7	9	—

15.7 Coordinate Predictions for Undetected Shell Candidates

NGC 3338 (K2-1): Barred spiral, Leo, ~74 Mly, RA=10h42m, Dec=+13°44'. Diameter >110,000 ly. Delta from Shell n=2: 1.5°. No dynamical BH mass exists. Predicted spin: retrograde. Recommended: ALMA CO(2-1) molecular gas dynamics. (OT-26)

NGC 3370 (K2-2): 'Silverado Galaxy', Sc spiral, Leo, ~82 Mly, RA=10h47m, Dec=+17°16'. Comparable to Milky Way. Delta from Shell n=2: 2.1°. No dynamical BH mass exists. Predicted spin: retrograde. Recommended: VLT/SINFONI stellar kinematics. (OT-27)

Designation	l (gal)	b (gal)	RA (J2000)	Dec (J2000)	Dist. nearest	Spin
K2-1 / NGC 3338	105.4°	+34.9°	10h42m	+13°44'	>28°	retrograde
K2-2 / NGC 3370	117.7°	+37.3°	10h47m	+17°16'	>21°	retrograde
K2-3	55.5°	-82.9°	18h38m	-33°39'	>28°	retrograde
K2-4	68.5°	-85.7°	18h39m	-30°33'	>26°	retrograde
K2-5	93.2°	+29.8°	10h10m	-09°01'	>18°	retrograde

Designation	l (gal)	b (gal)	RA (J2000)	Dec (J2000)	Spin
K1-1	282.0°	-29.3°	22h29m	+03°04'	prograde
K1-2	327.0°	-29.3°	23h36m	-33°30'	prograde
K1-3	297.3°	-33.2°	22h42m	-10°12'	prograde
K1-4	343.0°	-20.5°	00h39m	-44°09'	prograde
K1-5	312.7°	-33.2°	23h02m	-22°03'	prograde

16. Open Tasks and Future Work

#	Task	Status	Priority
OT-1	Analytic $D_{f,diss} = 1/(n \cdot D_{f,geo})$ from tau-isotropy	CLOSED V8.1	*****
OT-2	f_{echo} from first principles: verify $f_{echo} = \exp(D_{f,eff} \cdot \ln(\dots))$	Open	****
OT-3	Numerical confirmation $G_{eff} = G/(2c^2)$ from L_{total} variation	Open	***
OT-4	α from Milky Way rotation curve \rightarrow verify $k \sim O(1)$	Open	***
OT-5	KS-test θ_0 shell spectrum vs full NED/HyperLeda SMBH catalog	EVALUATED V18.0 — Ch. 15	***
OT-6	Katz-FD: method clarified; Box-Counting FD requires >100 objects from NEB	REFORMULATED V18.0	****
OT-7	$w(z)$ power-law curve from $D_f=1.8$ vs DESI DR2/DR3 data	Open	****
OT-8	Numerical exploration of M_{meta} (Metageometra Mandelbrot set)	Open	***
OT-9	C_{Zeit} : monoidal category? Functor to Topos?	Open	**
OT-10	Delta-theta from Megavacuum initial conditions — full analytical derivation	Open	***
OT-11	GCD_eps: verify θ_0 from full SMBH angle catalog independently	CONFIRMED V18.0: $58.963^\circ \Delta=0.313^\circ$	***
OT-12	Gamma-Functional regime-shift detection in power grid cascade models	Open	**
OT-13	SRM eigenmode spectrum: numerical computation of $ A_n ^2$ from cavity geometry	Open	****
OT-14	SRM halo profile: fit to observed galaxy rotation curves (SPARC sample)	Open	****
OT-15	SRM + baryonic feedback: derive $\delta_{Sigma}(r)$ from torsion compression	Open	***
OT-16	$\delta_{a0}/a_0 = \delta_{H0}/H_0$ — FSB	RESOLVED V10.0	*****
OT-17	Phantom Crossing as anti-time echo — projection operator formalism	Open	*****
OT-18	KS-test: RAR residuals vs Delta-theta_shell	Open	****
OT-19	SMBH shell angle $\theta_0(z)$ at high z via JWST	Open	***
OT-20	Precession cycle T_{prec} as Tier-3 resonance — formal proof	Open	****
OT-21	Planet 9/PBH as 5th sub-harmonic; HTM-OT21-A follow-up	Open	*****
OT-22	SEC formal proof from S^3 field equations	Open V14.0	*****
OT-23	Cosmic voids at non- θ_n positions; filaments at θ_n — KS-test SDDS	Open V16.0	*****
OT-24	H_0 irregularities over cosmic time as τ_{extern} signal from Megavacuum	Open V16.0	****
OT-25	L_{meta} : formal derivation of vacuum shell yield rate; relation to dark energy	Open V16.0	*****
OT-26	NGC 3338: ALMA CO(2-1) spin measurement — retrograde predicted (NEW V18)	NEW V18.0	*****
OT-27	NGC 3370: VLT/SINFONI stellar kinematics spin measurement (NEW V18)	NEW V18.0	*****
OT-28	Extend spin-alternation test to $n \geq 6$ confirmed objects for $p < 0.05$ (NEW V18)	NEW V18.0	*****
OT-29	GCD_eps on K2-1..K2-5 and K1-1..K1-5 candidates	CONFIRMED V18.0: $\Delta < 0.01^\circ$	***

Appendix A — Numerical Reference Table

Symbol	Value	Derivation / Source	Used In
H0 (CMB)	67.4 km/s/Mpc	Planck 2018	t0, L, a0(HTM)
H0 (local)	73.0 km/s/Mpc	SH0ES / H0DN 2026	FSB, a0 comparison
t0	4.352×10^{17} s	1/H0	L, a0, eta, SRM
c	2.998×10^8 m/s	Physical constant	a0, r_s, dimensional checks
rho_DE	6.034×10^{-27} kg/m ³	Planck 2018	L, a0, eta
L	1.386×10^{-44} kg·m ⁻³ ·s ⁴	rho_DE/t0 (def.)	All F(L) components
a0 (HTM)	1.097×10^{-10} m/s ²	$c/(2\pi \cdot t_0)$	RAR, MOND, SRM
a0 (obs.)	1.20×10^{-10} m/s ²	McGaugh et al. 2016	FSB comparison (8.6%)
tau (inflation)	10^{-32} s	End of inflation epoch	eta, f_echo
eta (obs.)	6.1×10^{-10}	Planck 2018 / BBN	f_echo calibration
f_echo (req.)	$\sim 2.65 \times 10^{40}$	$\text{eta}/(\text{tau}/t_0)$	eta derivation
D_f,geo	~ 0.77	$(3/\pi) \cdot \arcsin(\alpha \cdot \sin(\Delta\theta_0))$	Geometric fractal (Tier 3)
D_f,diss	~ 0.44	$1/(3 \cdot D_{f,\text{geo}})$ — Thm V8.1	Dissipative fractal (Tier 2)
D_f,eff	~ 0.34	$D_{f,\text{geo}} \times D_{f,\text{diss}}$	f_echo; SRM halo slope
D_f (w-drift)	~ 1.8	Anti-time \sim M layer	w(z) formula
theta_0	58.65° approx 59°	$\arccos(\cos 25^\circ \cdot \cos 55^\circ)$	Shell spectrum
G_eff	$G/(2c^2)$	Weak-field limit L_total	tau formula
l_D, b_D	305°, +25°	M31/M33 great-circle pole	Duality sphere D
r_s (SRM)	approx 42.3 kpc	$c^2/(2\pi \cdot a_0)$	SRM scale radius
SRM slope	approx -1.205	$-2/(2 \cdot D_{f,\text{eff}})$	SRM halo inner profile
alpha (FSB)	0.7433	$(3 \cdot D_{f,\text{geo}})/3$	Fractal Scale Bias exponent
M31 b/a	approx 0.27 (i=77°)	Beaton et al. 2007	SEC — V14.0
M33 b/a	approx 0.50 (i=54°)	de Vaucouleurs 1991	SEC — V14.0
T_prec	25,771.57 years	Bretagnon 2003; NASA	OT-20
L_meta	TBD	Vacuum shell yield rate	OT-25 — V16.0
tau_extern	TBD	Neighbouring rift torsion	OT-24 — V16.0
NGC 3338	RA 10h42m, Dec +13°44'	NED; V18.0 OT-26	K2-1 / Shell n=2 candidate
NGC 3370	RA 10h47m, Dec +17°16'	NED; V18.0 OT-27	K2-2 / Shell n=2 candidate
GCD_eps result	58.963° (all), 59.169° (index)	V18.0 OT-11	Independent theta_0 confirmation

Appendix B — Complete Derivation Chain (Anti-Post-Hoc Evidence)

This appendix documents the precise sequence of derivations across all versions, constituting the primary evidence that no element was introduced after observational comparison. Each step was formulated before the subsequent result was known.

Version	What was derived	What was NOT yet known at that point
v0.2	Dark matter as information-cavity echo; dual sectors; π as tuning constant	No Λ , no θ_0
v0.8	Centripetal stabilisation geometry; BH as π -boundary	No interface formula, no S^3 model
v0.9	S^3 diagonal torsion*; time as torsion rotation; Noether M_{31}/M_{33} duality	No Λ , no θ_0 , no Df
v4.0	S^3 tau formula; Lagrangian; $M_{31}/M_{33} \rightarrow \theta$	No Df closure, no 3-6-9 proof, no η
v5.1	Node conditions; Katz-FD; M_{meta} ; θ_0 shell speed	No π (SCP) proof, Df still inconsistent
v6.1	$\pi_3(S^3)=Z \rightarrow n=3$; Df formula; f_{echo} , η , a_0 parameter	No Df discrepancy resolution, no SRM
v7.0	C_{Zeit} category with morphisms T, Φ , Ψ ; L as single π	No Df proof, no $\eta \times Df$, diss decomposition
V8.0/8.1	Df decomposition; Torsion-Isotropy Theorem; Df, diss	No SRM, no Megavacuum
V9.0	SRM cavity echo; hollow-chamber model; three Sigma	No FSB, outputable resolution
V10.0	FSB: $\delta a_0/a_0 = \delta H_0/H_0$ exactly	No Megavacuum, no τ_{extern}
V14.0	SEC: M_{31}/M_{33} selection formally justified on morphological grounds	Regional justification of v4.0 choice
V16.0	SMBHs as crossing points; Megavacuum; τ_{extern}	L_{meta} formal derivation still open
V17.0	All derivation chains unified; Katz-FD, M_{meta} , GCD	π , θ , τ , η formal derivation stopped
V18.0	OT-5 evaluated; OT-6 clarified; OT-11 confirmed; OT-20 confirmed	OT-26 through OT-29 not confirmed; η and τ not identified

* v0.9 note: A cube was used as a visualisation aid for the diagonal cross-offset (Kreuzversatz) of torsion forces. The formal structure is exclusively S^3 .

Document Status and Contact

This document is the complete self-contained master synthesis of the Metageometra framework as of V18.0 (2026). All content from V17.0 is preserved without abbreviation or omission. V18.0 adds: Chapter 15 (OT-5 full evaluation), Chapter 15.5 (Gear Mechanism), GCD_eps results for OT-11 and OT-29, OT-6 method clarification, Prediction #11 (NGC 3338 spin), Open Tasks OT-26 through OT-29, and corresponding entries in Appendices A and B.

The framework has not been peer-reviewed. It is shared for early scientific feedback and falsification testing. The author welcomes correspondence, critical analysis, and collaboration proposals.

Kevin Hannemann · Independent Researcher · Germany · 2026 · kallebutz0@gmail.com · @kalle96682 on X · stillsilent22-spec on GitHub · OSF: 10.17605/OSF.IO/94XPD · © Kevin Hannemann 2026 — All rights reserved. Draft for scientific review.