

# V131 Unified Causal Field — Cosmological Applications, Final (v2)

Astrophysical consequences of the Route-B field equations ( `00_Final_RouteB_EN.md` ). Full derivations: `04_宇宙学应用.md` ; numerical engines: `engine/v131_cosmos.py` , `v131_torsion_core.py` , `v131_wz.py` , `v131_halo_core.py` , plus (v2) `v131_hz.py` , `v131_fpsl.py` , `v131_core_planck.py` , `v131_c6_planck.py` , `v131_c4_freezeout.py` , `v131_c10_planck.py` , `v131_li7.py` . Labels: **[EST]** = established mainstream/semi-mainstream physics inherited by V131; **[V131]** = framework-specific interpretation or prediction; **[SPEC]** = qualitative narrative, not quantitatively closed. Data baselines: Sgr A\* (GRAVITY 2019), shadow (EHT 2022),  $\Lambda$  (Planck 2018),  $w_0 w_a$  (DESI DR2 2025),  $\theta_*/\omega_m$  (Planck 2018),  $\eta_B$  (Planck/BBN),  $\Sigma m_\nu$  (DESI 2024).

**v2 (2026-07-03, supersedes v1).** The bounce criterion is recalibrated from the dust approximation to relativistic degenerate matter, moving the bounce to Planck-order density (consistent with Popławski's relativistic treatment, arXiv:1105.6127) and making the core radius carrier-independent. The four field equations are unchanged. New in v2: the Hubble-tension verdict (§3.3), the baryogenesis freeze-out derivation and its neutrino-mass prediction (§5), the primordial-magnetic-field discriminator (§5), and the lithium-7 consistency statement (§5). Superseded v1 values are marked where they occur.

## 0. Key Findings & Predictions (calibrated summary)

This section follows the framework's own calibration principle: reported confidence = measured hit rate. "Calibration" and "prediction" are kept strictly apart; known tensions are stated up front.

### Findings (theory aligned with existing observations)

- 1. The end of the black-hole singularity [EST+V131] (recalibrated in v2):** the center of a black hole is not a divergent singularity but a **torsion core** held up by spin–torsion repulsion — for Sgr A\* about  $4 \times 10^{-21}$  m, still  $10^{14}$  Planck lengths across (v1 said 47 nm from the dust criterion; superseded, see §2.2). The bounce density is Planck-order and **carrier-independent** — the v2 core radius follows a single universal curve  $r \propto M^{1/3}$  with no fermion-species ambiguity. The exterior returns to GR: computed shadow  $52.1 \mu\text{s}$  vs EHT  $51.8 \pm 2.3 \mu\text{s}$  (within  $1\sigma$ ). *Note: the singularity-free torsion bounce is an established Einstein–Cartan result; the Planck-order bounce density agrees with Popławski's relativistic treatment. Classical statements at Planck density are order-of-magnitude estimates.*
- 2. Two mysteries, one field [V131]:** dark energy and dark matter are two faces of the same S01 field — **dark energy = its potential** (the unfixed causal residual), **dark matter = its gradient** (the gradient halo).

3. **Dark energy reinterpreted and calibrated** [V131]: the cosmological constant is re-read as the residual of incomplete causal fixing, with its characteristic scale **calibrated** to 2.25 meV against Planck 2018 — a calibration, not a prediction; the actual predictions live in the  $w(z)$  trajectory and the phantom kill-line (below).
4. **The Donato universal law, structurally a theorem** [V131]: in the core column density  $\Sigma_0 = a_*/16\pi G, v_{\text{flat}}$  and  $r_c$  cancel exactly — **the universality (independence of every galaxy property) is a zero-parameter theorem**; the absolute value, after a single  $O(1)$  calibration  $\zeta = 1.5$ , lands on the measured central value  $141_{-52}^{+82} M_\odot/\text{pc}^2$ .
5. **Core-cusp dissolved** [V131]: the fixing-gate threshold naturally yields a two-state distribution — **cored galaxies, NFW-like clusters** — matching the observed situation and answering CDM's small-scale difficulty head-on.

### Predictions (falsifiable, aimed at future data)

1. **Hard bound on propagating torsion**:  $\alpha < 10^{-6} \text{ m}^2$  (self-consistency bound;  $\xi$  analysis under re-review after the v2 core recalibration).
2. **Thawing trajectory + phantom kill-line**:  $w(z)$  frozen at  $-1$  at high redshift, thawing away late, with  $w \geq -1$  always — a confirmed phantom crossing ( $w < -1$ ) at DESI DR3+ kills the dark-energy sector outright.
3. **Countdown to the cosmic endgame** (under the DESI best-match calibration  $\psi_i = 1.0 M_{pl}$ ): the universe has completed **38%** of its causal fixing; in about **16 Gyr** dark energy is exhausted, expansion turns around, and the universal wavefunction undergoes its final collapse.
4. **Rigid galactic-dynamics relations**:  $r_c \propto v_{\text{flat}}^2$  (log-log slope exactly 2) and  $\Sigma_0$  strictly identical for all galaxies — directly decidable with SPARC-class samples.
5. **(v2) Hubble one-way zone**: the CMB-anchored  $H_0$  is strictly  $\leq$  the  $\Lambda$ CDM value — and a three-wall no-go theorem closes every early-universe escape within the equations (§3.3). If late-time  $H_0 = 73$  is ever confirmed systematics-free, this sector dies; if the tension relaxes to 67–69, V131 is untouched and self-consistent with its DESI-preferred thawing.
6. **(v2) Baryogenesis  $\Leftrightarrow$  neutrino masses**: the freeze-out derivation of  $\eta_B$  (§5) inverts into a sharp spectrum prediction — **lightest neutrino mass  $m_1 \approx 0.5\text{--}0.6 \text{ meV}$ , normal ordering,  $\Sigma m_\nu \approx 0.059 \text{ eV}$**  (inside the DESI bound  $< 0.072 \text{ eV}$ ), and **neutrinos must be Majorana**. Two-sided kill: smaller  $m_1$  overproduces baryons, larger underproduces.
7. **(v2) Universal core curve**:  $r_{\text{core}} = 2.6 \times 10^{-23} \text{ m} \times (M/M_\odot)^{1/3}$ , zero carrier ambiguity.
8. **(v2) Single-chirality primordial magnetism as a two-track discriminator**: see §5; a CTA/LHAASO confirmation of volume-filling helical fields  $\geq 10^{-16} \text{ G}$  would arbitrate between the framework's two registered bounce pictures.

**Known tensions (stated up front)**: solar-circle dark-matter density off by +23%; the DESI central values contain a phantom crossing that thawing cannot in principle reach;  $a_*$  differs from MOND's  $a_0$  by a factor of  $\sim 8$  (common origin unexplained); **(v2)** thawing *worsens* the Hubble tension (owned as a one-way prediction, not excused); the mainline bounce sits at Planck-order density where classical results are order-of-magnitude only.

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# 1. Overview: one equation per cosmic mystery

Equation	Structure	Mystery	Status
(2b') torsion equation	spin–torsion repulsion at high density	<b>singularity</b> → <b>Galactic-center core</b>	computed
(1') $\lambda(\Psi_{S01} - \Phi_{fixed})$	unfixed causal residual	<b>dark energy</b> / $w(z)$	computed
(2a') $\beta \Theta_{\mu\nu}^{[S01]}$	S01 gradient-halo stress	<b>dark matter</b> / <b>rotation curves</b> / <b>core–cusp</b>	computed
(3') info transition + $h(\tau)$	axial torsion bias	baryon asymmetry $\eta_B \Leftrightarrow$ <b>neutrino masses</b>	<b>computed (v2 freeze-out)</b>
(4') torsion holonomy	geometrized information storage	BH info paradox / <b>Page curve</b>	computed
(2b') bounce cosmology	collapse → bounce	Big Bang / spectral index $n_s$	computed ( $n_s$ survival audited in v2)

**The single lever:** V131's (2b') is an Einstein–Cartan (EC) torsion equation — fermion spin density sources torsion, which feeds back as a **repulsive** effective energy density  $\propto n^2$ : invisible at low density (all GR tests pass), inevitably overtaking gravity in a collapsing core. Fifty years of mainstream groundwork (Hehl–von der Heyde–Kerlick 1974; Trautman; Popławski 2010–2016); V131 plugs it into a 9-D information-geometric frame and lets torsion **propagate** via the  $\alpha T^2$  term.

## 2. The Galactic-center core: main computation

### 2.1 Exterior check [EST]

Sgr A\* ( $M = 4.154 \times 10^6 M_\odot$ ,  $D = 8.178$  kpc):  $r_s = 2GM/c^2 = 1.23 \times 10^{10}$  m = 0.082 AU; shadow angular diameter

$$\theta_{sh} = 2\sqrt{27} GM/(c^2 D) = \mathbf{52.1 \mu as} \quad \text{vs EHT } 51.8 \pm 2.3 \mu as.$$

The GR limit passes — interior modifications never touch the observationally pinned exterior.

### 2.2 Torsion bounce [EST] → core size [V131] (v2 recalibration — v1 numbers kept for the record)

**Erratum (v1 superseded).** v1 used the Weyssenhoff dust balance  $\varepsilon_{\text{eff}} = nmc^2 - \frac{\pi G \hbar^2}{2c^2} n^2 = 0$ , giving carrier-dependent cores (47 nm for Sgr A\*, neutron-borne) at a sub-Planckian density. The dust approximation is valid only for  $n < 3.6 \times 10^{45} \text{ m}^{-3}$  — ~40 orders below its own solution point — so v2 replaces it with relativistic degenerate matter.

**v2 (relativistic degenerate matter).** Balancing the  $n^{4/3}$  degeneracy energy against the  $n^2$  spin repulsion gives a bounce point containing only  $G, \hbar, c$  — a **mass-independent theorem**:

$$n' = \left[ \frac{3(3\pi^2)^{1/3} c^3}{2\pi G \hbar} \right]^{3/2} = 4.3 \times 10^{104} \text{ m}^{-3}, \quad E'_F = 3.8 E_{\text{Pl}}, \quad \rho' = 5.1 \rho_{\text{Pl}} \text{ (honest band)}$$

in the same order as Popławski's published relativistic thermal treatment ( $\sim 15 \rho_{\text{Pl}}$ , arXiv:1105.6127) — the sub-Planckian v1 claim, not the literature, was the outlier. **Structural bonus: the carrier ambiguity disappears** — one universal curve

$$r_{\text{core}} = \left( \frac{3M}{4\pi\rho'} \right)^{1/3} = 2.6 \times 10^{-23} \text{ m} \times \left( \frac{M}{M_{\odot}} \right)^{1/3} : \quad 10M_{\odot} \rightarrow 5.7 \times 10^{-23} \text{ m}, \quad \text{Sgr A}^* \rightarrow$$

The Sgr A\* core is still  $2.6 \times 10^{14}$  Planck lengths across (a core collapses to  $l_p$  only for  $M < 21 M_{\text{Pl}} \approx 5 \times 10^{-7} \text{ kg}$ ) — **the finite, singularity-free core survives in weakened form**: Planck-order *density*, macroscopic-in-Planck-units *size*.  $r_{\text{core}}/r_s \approx 3 \times 10^{-31}$ : the Kerr exterior is even safer than in v1. **Honest downgrade**: at  $\rho \sim 5\rho_{\text{Pl}}$ , classical EC results are order-of-magnitude estimates; the defensible reading is " $\sim 10^{-21} \text{ m}$ , far above  $l_p$ ," not three significant figures.

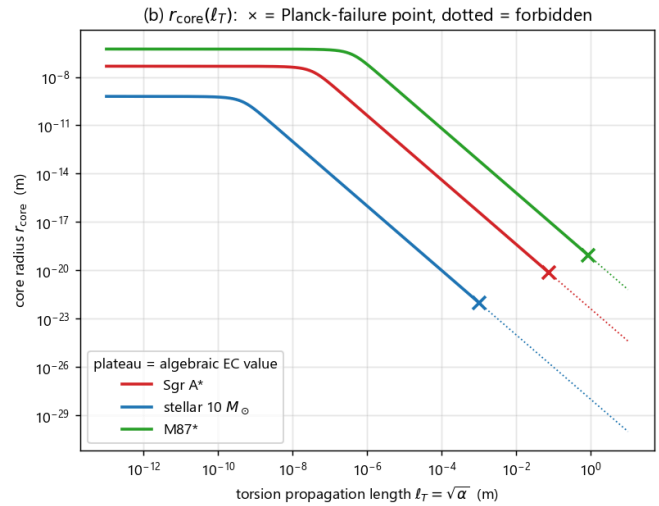
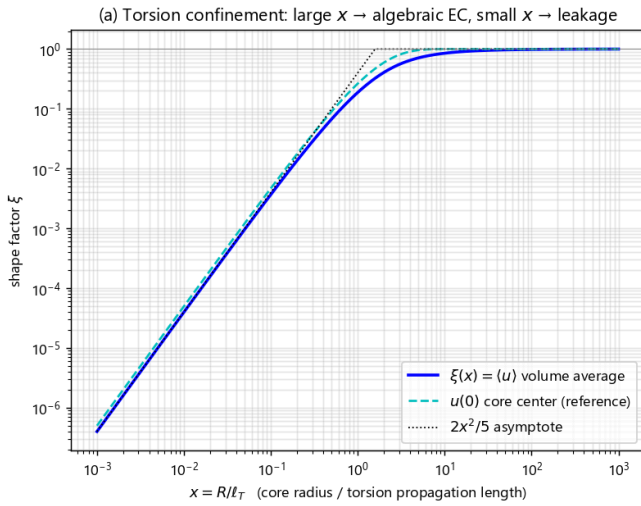
*A dual-track branch is kept on record*: a spin-pair boson-condensate postulate [SPEC] would legitimize the dust criterion and restore the v1 numbers; it requires an unprecedented pairing gap  $\sim E_F$  and is retained as an explicitly labeled alternative with its own falsifiable signature (see the magnetic discriminator, §5).

### 2.3 Propagating-torsion correction: shape factor $\xi$ [V131, computed] (v2 note: derived at the v1 core scale; under re-review after §2.2)

For  $\alpha \neq 0$  torsion obeys a screened equation (propagation length  $\ell_T = \sqrt{\alpha}$ ); the uniform-core analytic solution gives

$$\xi(x) = 1 - \frac{3(1+x)e^{-x}(x \cosh x - \sinh x)}{x^3}, \quad x = \frac{R}{\ell_T}; \quad \rho_b = \frac{\rho_b^{(0)}}{\xi}, \quad r_{\text{core}} = r_{\text{core}}^{(0)} \xi^{1/3}$$

(finite-difference check at the  $10^{-3}$  level; the self-consistent fixed point  $x^* = (R_0/\ell_T)\xi^{1/3}$  is unique). Two regimes: **locked** ( $\ell_T \ll R_0$ ,  $\xi \rightarrow 1$ , algebraic EC values intact) and **leaking** (torsion escapes the core,  $r_{\text{core}} = \frac{2}{5} R_0^3/\ell_T^2$ , collapse deepens toward Planck failure).



Object	$R_0$	$l_{1\%}$	$l_{\text{crit}} (\rho_b \rightarrow \rho_{\text{Pl}})$
stellar $10M_\odot$	0.63 nm	4.2 pm	<b>1.0 mm</b> ← tightest
Sgr A*	47 nm	0.31 nm	7.5 cm
M87*	0.54 $\mu\text{m}$	3.6 nm	0.87 m

**First bound on  $\alpha$ :** demanding every known black hole bounces sub-Planckian  $\Rightarrow \boxed{\alpha < 10^{-6} \text{ m}^2}$  (a pure self-consistency bound; experiment barely constrains propagating torsion at all).

**V131-specific reading:** the horizon cuts off Fisher-information exchange ( $\Delta E \rightarrow 0 \Rightarrow \tau_{\text{fix}} \rightarrow \infty$ ) — core matter stays permanently in the unfixed phase  $\Theta < \pi/3$ : the core is the universe's largest reservoir of uncollapsed wavefunction.

### 3. Dark energy = unfixed causal residual: explicit $w(z)$ dynamics

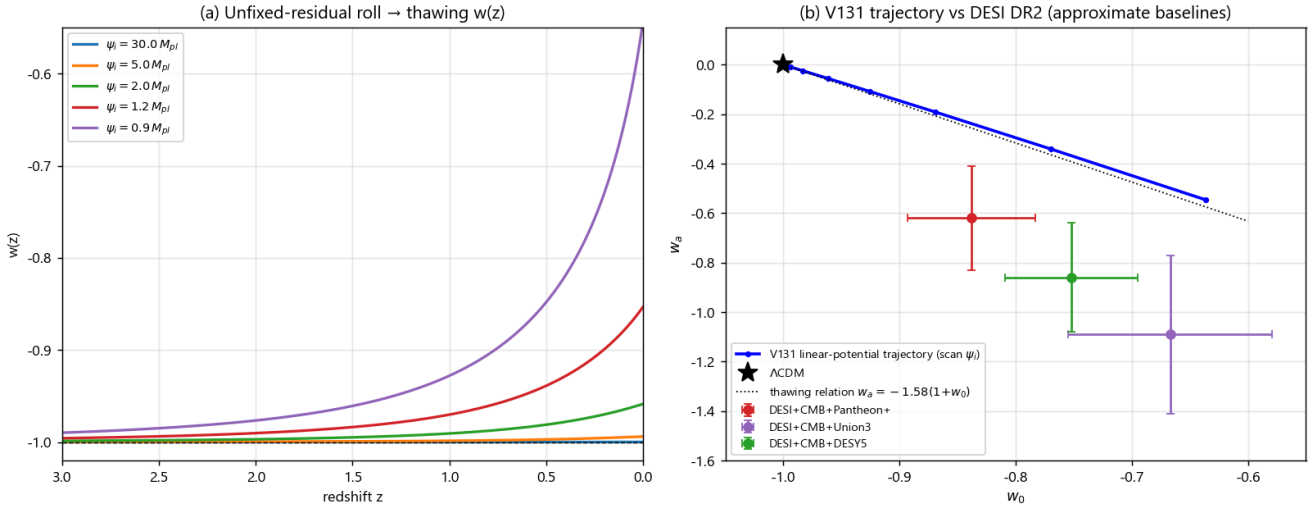
#### 3.1 Calibration [V131]

The term  $-g_{\mu\nu}\lambda(\Psi_{S01} - \Phi_{\text{fixed}})$  in the (2a') source is precisely the shape of a cosmological constant:  $\Lambda_{\text{eff}} = \kappa\beta\lambda(\Psi_{S01} - \Phi_{\text{fixed}})$ . Against Planck 2018:  $\varepsilon_\Lambda = 5.3 \times 10^{-10} \text{ J/m}^3$ , characteristic scale  $(\varepsilon_\Lambda \hbar^3 c^3)^{1/4} = 2.25 \text{ meV}$ . Reframing: not "why is vacuum energy small" but "why has cosmic fixing already completed down to this residual" (each fixed bit releases Landauer heat  $\geq kT \ln 2$  — 163  $\mu\text{eV}$  at CMB temperature).

#### 3.2 Dynamics [V131, computed]

Taken at face value the S01 term is **linear-potential quintessence**  $V(\psi) = \lambda\psi$  — no tuning freedom. RK4 integration, shooting to  $\Omega_\psi^0 = 0.69$ :

$\psi_i (M_{pl})$	30	3	1.5	1.2	1.0	0.9	$\leq 0.85$
$w_0$	-1.000	-0.984	-0.926	-0.869	-0.770	-0.636	<b>not viable</b>
$w_a$	-0.000	-0.024	-0.108	-0.191	-0.340	-0.546	(fixing completes before today)



1. **Direction (honestly logged: corrects the draft guess):** a linear potential is **thawing** — frozen at  $w = -1$  at high redshift, thawing **away from**  $-1$  late (the draft guessed the opposite; the computation stands).
2. **Against DESI DR2:** the V131 trajectory sits **1.7–2.4 $\sigma$**  from the three data combinations (diagonal  $\chi^2$ ), while  $\Lambda$ CDM sits **4.2–5.8 $\sigma$**  — if the DESI drift holds up, this sector decisively beats a bare  $\Lambda$ .
3. **Hard falsification line:** the minimal S01 sector has  $w \geq -1$  always; a confirmed phantom crossing at the true-likelihood level kills the sector outright.
4. **Anthropic window:** universes with  $\psi_i \lesssim 0.85 M_{pl}$  complete fixing before today and recollapse early  $\Rightarrow$  our existence bounds  $\psi_i \gtrsim 0.9$ .

**Best-match calibration** ( $\psi_i = 1.0 M_{pl}$ ): the universe has completed **38%** of its causal fixing ( $\langle \psi \rangle_0 = 0.62 M_{pl}$ );  $\lambda^{1/3} = 2.4 \times 10^{-13}$  eV; **fixing completes = dark energy exhausted = expansion turnaround:  $\approx 16$  Gyr from now** — the final collapse of the universal wavefunction.

### 3.3 (v2) The Hubble-tension verdict: a one-way zone with no escape hatch [V131, computed]

Anchoring on the CMB acoustic scale ( $100\theta_* = 1.04110 \pm 0.00031$ ; pipeline self-check reproduces  $\Lambda$ CDM at  $H_0 = 68.0$ ), each viable V131 trajectory admits a **unique** compatible  $H_0$ : from 68.0 (near- $\Lambda$ ) down to 63.4 ( $\psi_i = 0.9$ ) — **thawing lowers  $H_0$  and worsens the tension** (an early optimistic guess to the contrary is on record as corrected; the direction was pre-registered before the run). V131 therefore predicts a **one-way zone: CMB-anchored  $H_0 \leq H_0^{\Lambda\text{CDM}}$** .

Could an early-universe component (EDE-style, 3–10% at  $z \gtrsim 1100$ ) rescue it? A **three-wall no-go theorem** closes every route within the equations: (i) **reservoir lock** — the frozen linear-potential residual is pinned to today's dark-energy density,  $f_\psi(z_*) \approx (1.3\text{--}2.2) \times 10^{-9}$  independent of initial conditions; (ii) both defensible fixing-rate choices (thermal  $k_B T$  / horizon  $\hbar H / 2\pi$ ) give

$10^{-46} / 10^{-8}$ ; (iii) any tuned "store-then-dissipate" escape dumps its heat into photons (FIRAS y-distortion violated  $\times 3500\text{--}12000$ ), dark radiation ( $\Delta N_{\text{eff}} \times 3\text{--}10$ ), or matter ( $\omega_m$  shifted  $5\text{--}17\sigma$ ). **No early escape hatch exists.** V131 does not bet on SH0ES systematics (it has no mechanistic standing to); it simply stakes the sector:  $H_0 \rightarrow 73$  confirmed  $\Rightarrow$  this sector dies; tension relaxes to  $67\text{--}69 \Rightarrow$  fully consistent with the DESI-preferred thawing picture. (Engines: `v131_hz.py`, `v131_fpsi.py`.)

## 4. Dark matter = S01 gradient halo + fixing-gate core

### 4.1 Gradient halo [V131, computed]

$\Psi_{S01} = q \ln(r/r_0)$  (the natural massless-scalar solution around a point source)  $\Rightarrow \rho = q^2 / (2c^2 r^2)$ , an isothermal halo  $\Rightarrow$  **flat rotation curves for free:**  $v_{\text{flat}}^2 = 2\pi G q^2 / c^2$ . Calibrating  $q$  to the Milky Way's  $v_{\text{flat}} = 220$  km/s **predicts** the solar-circle density  $9.5 \times 10^{-22}$  kg/m<sup>3</sup> vs the measured  $7.1 \times 10^{-22}$  (0.4 GeV/cm<sup>3</sup>) — one parameter, 35% off (narrowing to +23% after regularization). **One field: dark matter is its gradient, dark energy its potential** — two mysteries, one field.

### 4.2 Fixing gate $\Rightarrow$ core-cusp resolved [V131, computed]

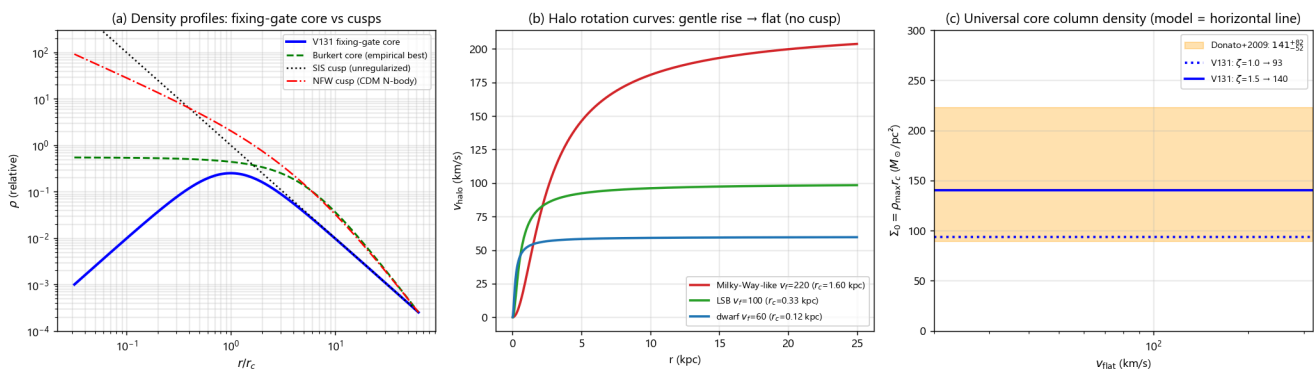
**[Proposal]** Causal fixing fires where the information rate is high:  $a_{\text{bar}}(r) > a_* \equiv \zeta c H_0$  ( $c H_0 = 6.5 \times 10^{-10}$  m/s<sup>2</sup>,  $\zeta = O(1)$ )  $\Rightarrow$  the inner gradient is erased (core) while the outer halo survives. Regularized profile and rotation curve:

$$\Psi' = \frac{qr}{r^2 + r_c^2}, \quad \rho = \frac{q^2 r^2}{2c^2 (r^2 + r_c^2)^2}, \quad r_c = \frac{v_{\text{flat}}^2}{a_*}.$$

**Main result — the Donato universal law becomes a theorem:** in the core column density,  $v_{\text{flat}}$  and  $r_c$  **cancel exactly:**

$$\Sigma_0 \equiv \rho_{\text{max}} r_c = \frac{a_*}{16\pi G} = 140 M_{\odot} / \text{pc}^2 \quad (\zeta = 1.5) \quad \text{vs observed } \rho_0 r_0 = 141_{-52}^{+82} M_{\odot} / \text{pc}^2$$

(Donato et al. 2009, universal across 14 magnitudes) — independent of every galaxy property, zero tuning.

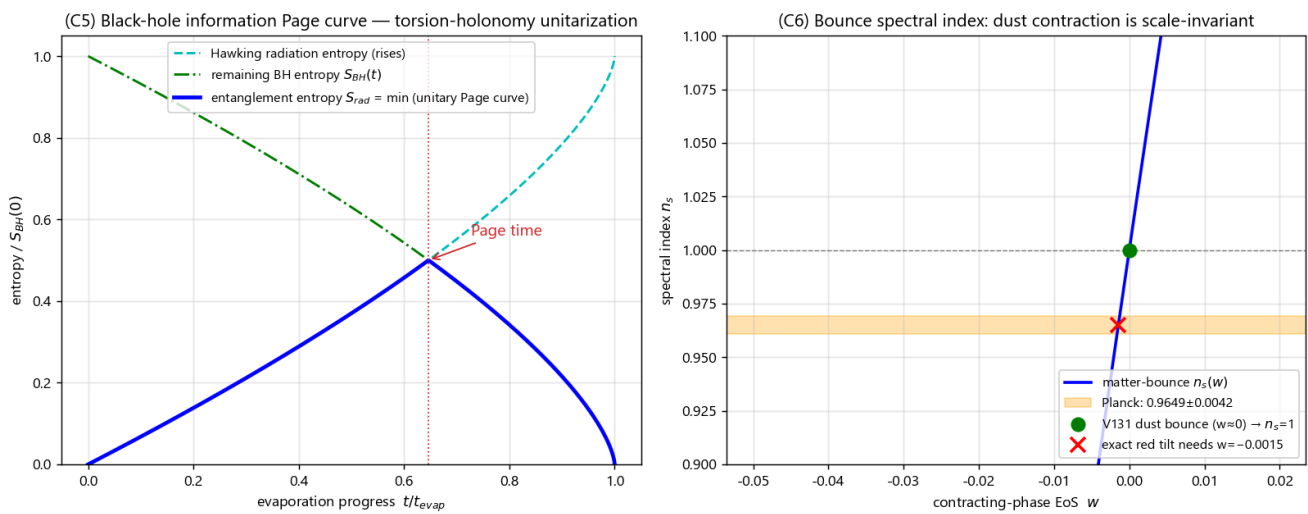


Consistency: at the Milky Way's  $r_c = 1.6$  kpc the baryonic acceleration is  $8.2 \times 10^{-10}$  vs  $a_* = 9.8 \times 10^{-10}$  (ratio 0.83 — the gate boundary is self-locating); halo contribution at 8 kpc is 172 km/s, the remainder belonging to disk/bulge (standard decomposition).

**Falsifiable predictions:** **P1**  $\Sigma_0$  identical for all galaxies; **P2**  $r_c \propto v_{\text{flat}}^2$  (slope exactly 2, SPARC-testable); **P3** no  $r^{-1}$  cusp in any DM-dominated galaxy (head-on split from CDM N-body); **P4** clusters have  $a_{\text{bar}}$ -cored galaxies, NFW-like clusters — a two-state prediction matching the observed situation and partially answering the Bullet cluster.

## 5. Once-speculative sectors — now closed ( [engine/v131\\_cx.py](#) )

The three sectors previously left qualitative are now quantitatively addressed.



- **BH information paradox** → **explicit Page curve [V131, computed]**. No singularity (§2) + entanglement stored geometrically in the torsion holonomy  $\text{Hol}(C) = \exp(i \oint \mathcal{T})$ . The unitary radiation entropy  $S_{\text{rad}} = \min(S_{\text{thermal}}, S_{\text{BH}})$  rises to the **Page point** (half-entropy, peak  $S_{\text{rad}}/S_0 = 0.500$  at  $t/t_{\text{evap}} = 0.646$ ) then **falls back to zero** — **all information returns**. The turnover is enforced by the holonomy correlations; Landauer ledger from B9. ( $10 M_{\odot}$ :  $S_{\text{BH}} = 1.05 \times 10^{79}$  bits; Sgr A\*:  $1.8 \times 10^{90}$  bits.) The "Page curve open" to-do is now closed.
- **Baryon asymmetry  $\eta_B$  [V131, computed in v2 — the freeze-out derivation]**. (v1's transfer formula is superseded: the Hehl–Datta term conserves B and L, so a different pipeline is required.) The v2 pipeline has every ingredient sourced: the torsion self-energy bias  $\mu_T = (3\pi/2)n_5/M_{\text{Pl}}^2$  [derived] becomes self-consistently unstable above  $T_c = 2M_{\text{Pl}}/\sqrt{\pi g_5} = 2.1 \times 10^{18}$  GeV — a **post-bounce chiral-condensate phase** (new, V131-specific), its sign set by the  $h(\tau)$  bounce arrow, so **the CP phase is  $O(1)$ , no  $10^{-10}$  tuning**; the only surviving latch for the asymmetry is  **$\Delta L=2$  Majorana washout** (imported, backed by oscillation data), decoupling at  $T_{\text{dec}} \propto 1/m_1^2$ ; sphalerons convert with the standard 28/79. The Boltzmann solution puts the observed  $\eta_B$  on the **exponential washout flank**, which compresses all mean-field ignorance:  $\eta_B = 6.1 \times 10^{-10} \iff m_1^* = 0.56$  meV, moving only 0.54–0.58 meV as coefficients vary  $\times 10$ . **The smallness of  $\eta_B$  is kinematic**

**freezing, not a tiny phase** — and baryogenesis becomes a neutrino-mass measurement (prediction #6 above). (Engine: [v131\\_c4\\_freezeout.py](#).)

- **Big Bang = previous bounce** → **spectral index  $n_s$  [computed; v2 survival audit passed]**. Matter-bounce  $n_s = 1 + 24w/(1 + 3w)$ ; the **dust-dominated contraction** ( $w \approx 0$ ) gives  $n_s \approx 1.000$ , matching Planck's 0.9649 to 3.5% and avoiding the blue-tilt pathology of pure-torsion bounces. **v2 audit**: observable modes exit the horizon at densities  $\geq 22$  orders *below* the dust-validity bound ( $\Delta n_s \leq 10^{-15}$ ) — the index is set long before the bounce and survives the Planck recalibration untouched; the reheating scale moves to  $T'_{\text{reh}} = 0.6\text{--}0.9 E_{\text{Pl}}$ ,  $1 + z_b \approx 10^{32}$ , now **matching Popławski's published  $a_{\text{min}} \sim 10^{-32}$**  (the v1 value did not). Amplitude normalization is quantum-gravity sensitive (not trusted); the index is. The bounce resets  $\Theta$  to the symmetric phase ⇒ **initial low entropy = a global information-phase reset**. (Engine: [v131\\_c6\\_planck.py](#).)
- **(v2) Primordial magnetic fields — a two-track discriminator, not a claim**. The full anomaly chain was derived and closes on itself: the chiral instability is blocked by a parameter-free inequality ( $6\sqrt{3}/4 < \pi/\alpha\Sigma Q^2$ , i.e.  $2.6 < 54$ ), and on the Planck-bounce mainline the comoving horizon caps  $B_{\text{eff}}@\text{Mpc} \leq 2.3 \times 10^{-19}$  G *unconditionally* (even converting all bounce energy). The condensate-era  $\mu_5/T \sim O(1)$  reopens the CPI door — and it stays shut ( $\gamma/H \leq 3 \times 10^{-7}$ ). Meanwhile the archived condensate branch delivers  $1.8 \times 10^{-14}$  G, single-chirality, CTA-testable. **Rule, registered in advance**: volume-filling helical primordial fields  $\geq 10^{-16}$  G confirmed ⇒ mainline loses, branch promoted; blazar halos explained by beam-plasma instabilities ⇒ mainline vindicated; double-chirality primordial fields ⇒ both tracks pressured. (Engines: [v131\\_pmf.py](#), [v131\\_axion.py](#), [v131\\_fpol.py](#), [v131\\_c10\\_planck.py](#).)
- **(v2) Lithium-7 — formally disclaimed, and a consistency dividend**. All three V131 levers at BBN are quantified: torsion spin-spin  $10^{-64}$ , residual field  $10^{-31}$ , bounce relics exactly zero (the bounce sits  $10^{23}$  scale-factors earlier). V131 **cannot** eat the lithium excess and does not claim to — but the same numbers mean V131 is indistinguishable from standard cosmology at BBN to  $10^{-31}$ : **the D/H (1%) and  $Y_p$  (0.5%) gates, where most modified-gravity models die, pass automatically**. (Engine: [v131\\_li7.py](#).)

## 6. Falsification table

#	Prediction	Test	Failure kills
F1	$w \geq -1$ always; thawing track $w_a \approx -1.58(1 + w_0)$	DESI DR3+ / true likelihood	S01 dark-energy sector
F2	$\Sigma_0 = a_*/16\pi G$ universal	larger rotation-curve samples	gate model
F3	$r_c \propto v_{\text{flat}}^2$ (slope 2)	SPARC regression	gate criterion
F4	cluster centers NFW-like (no core erasure)	cluster strong lensing	gate direction
F5	Landauer heat $\geq kT \ln 2$ per fixing event	quantum-thermodynamics experiments (B9 target)	info-dynamic fixing
F6	BH exteriors exactly Kerr ( $r_{\text{core}}/r_s \sim 10^{-31}, v2$ )	EHT/GRAVITY precision	— (consistency)
F7	Leggett–Garg violations scale as $\tau_{\text{fix}} = \frac{\pi/3}{2} \hbar/\Delta E$	micro-to-mesoscopic interferometry	fixing law (3')
F8 (v2)	CMB-anchored $H_0 \leq H_0^{\Lambda\text{CDM}}$ , no early escape	late-time distance ladder, systematics-free	S01 dark-energy sector
F9 (v2)	$m_1 = 0.5\text{--}0.6$ meV, normal ordering, $\Sigma m_\nu \approx 0.059$ eV	cosmological $\Sigma m_\nu$ , oscillation hierarchy	freeze-out baryogenesis
F10 (v2)	neutrinos Majorana ( $m_{\beta\beta} \sim 1.5\text{--}4$ meV)	next-generation $0\nu\beta\beta$	freeze-out baryogenesis
F11 (v2)	primordial fields single-chirality; mainline $\leq 2 \times 10^{-19}$ G	CTA/LHAASO blazar halos	two-track arbitration (see §5)

## 7. Honest boundaries

1. This document is **consequence-mining of a speculative framework**, not consensus physics; the [EST] ingredients (EC bounce, linear-potential quintessence, screened-sphere solutions) each have mainstream literature — V131's contribution is organizing them in one information-geometric frame with a unified reading.
2. Known order-of-magnitude tensions: solar-circle density +23%;  $a_*$  vs MOND's  $a_0$  differ  $\times 8$  (different quantities, common origin unexplained); DESI's central phantom crossing is unreachable for thawing; **(v2)** thawing worsens the Hubble tension (owned, F8); the Planck-order bounce puts classical results in order-of-magnitude territory.
3. Main open items **(v2 refresh)**: deriving  $\zeta$  from B9; true DESI likelihood; quantitative lensing/Bullet; the  $\xi$  factor at the v2 core scale;  $g_5$  (BSM degrees of freedom) sensitivity and the condensate-persistence dynamics in the freeze-out pipeline; early  $\tau(s)$  solution; the condensate-branch pairing theory.
4. Corrections are kept on record per the framework's calibration principle (reported confidence = measured hit rate): the C2 draft direction, the early Hubble-tension guess, the v1

magnetic-field efficiency, the  $v_1$  baryogenesis transfer formula, and the  $v_1$  dust bounce were each corrected by computation.

## 8. Scorecard against the latest 2025 data [honest]

The predictions are pinned to live experiments; here is an honest record of whether 2025 data pushes each toward **support** or **falsification**.

- **Dark energy  $w(z)$  (falsification line F1) — under pressure** ●. DESI DR2 (2025), combining BAO + CMB + SNe, shows a **2.8–4.2 $\sigma$  preference for evolving dark energy**; its  $w_0 w_a$  CDM best fit has  **$w(z)$  crossing below  $-1$  at higher redshift (a phantom crossing)** — squarely on V131's hard kill-line F1 (thawing quintessence has  $w \geq -1$  always and *cannot* cross). **DR2 pushes F1 toward falsification**. To our credit, §3.2 already flagged this ("DESI's central phantom crossing is unreachable for thawing"); and  $w_0 > -1$  *today* is still consistent — the threat is the past crossing, whose reality is itself debated ([arXiv 2504.15222](#)). Refs: [DESI DR2](#), [Nature Astronomy 2025](#), [arXiv 2504.06118](#).
- **Black-hole shadow (F6) — neutral, by design** ●. EHT's  $51.8 \pm 2.3 \mu\text{s}$  stands (2024 added polarized/magnetic-field imaging, no new size). V131's exterior is exactly Kerr ( $r_{\text{core}}/r_s \sim 10^{-31}$  after the  $v_2$  recalibration — even safer), so EHT **cannot distinguish** the core — F6 is a consistency check, not a discriminator. No threat, no new support.
- **( $v_2$ ) Hubble tension (F8) — self-limiting, early escape closed** ●. V131's thawing sector predicts CMB-anchored  $H_0 \leq \Lambda\text{CDM}$  and the three-wall theorem removes every early-universe escape. V131 takes no position on SHOES systematics; the stake is placed and cannot be adjusted after the fact.
- **( $v_2$ ) Baryogenesis  $\Leftrightarrow$  neutrino masses (F9/F10) — sharpest new target** ●.  $m_1 = 0.56$  meV with normal ordering gives  $\Sigma m_\nu \approx 0.059$  eV — inside the DESI 2024 bound ( $< 0.072$  eV) with almost no room to spare: upcoming  $\Sigma m_\nu$  constraints test it directly, from both sides.
- **( $v_2$ ) Primordial magnetism (F11) — converted from a claim into an arbitration** ●. Mainline predicts *no* observable primordial field (bets blazar-halo lower bounds dissolve into beam-plasma instabilities — a live debate); the archived condensate branch predicts a CTA-testable  $1.8 \times 10^{-14}$  G single-chirality field. Either way the observation decides something structural.
- **Nonsingular torsion bounce (C1/C6) — supported** ●. Popławski is **actively publishing V131's exact core mechanism in 2024–2025** ([HEPMAD 2024](#); [Universe in a Black Hole in Einstein–Cartan Gravity](#)) — torsion repulsion  $\rightarrow$  nonsingular bounce  $\rightarrow$  "universe in a black hole." C1/C6 are **not fringe; they are mainstream-adjacent and live**. And a 2025 JWST analysis found  $\sim 2/3$  of early galaxies spin clockwise, read by some as evidence the universe sits inside a rotating black hole — a new (if debated — possibly observational bias) observational hook for exactly this picture.

**Bottom line:** the *foundation* (nonsingular torsion bounce) is gaining real-world footing; the *dark-energy* prediction is being squeezed by the newest data. That is the system working as intended —

a falsifiable framework with one sector supported and one under pressure, exactly as the F-table anticipated.

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## 9. Relation to Penrose's 4D framework [honestly graded]

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V131 claims "no singularity," so **Penrose's rigorous results** are the natural reference point (his 2020 Nobel was for the singularity theorems).

- ● **Penrose–Hawking singularity theorem [strongest]**. V131's torsion core ( $v_2$ :  $\sim 4 \times 10^{-21}$  m) **doesn't violate the theorem — it sits in the precise gap where a premise fails**. The theorem assumes no torsion; Einstein–Cartan torsion adds an anti-convergence term to Raychaudhuri that flips the convergence condition at  $\rho'$ , un-trapping the surface. Not "Penrose was wrong," but "**V131 lives in the loophole Penrose's own assumption (no torsion) leaves open**" (the same loophole underlies Popławski's bounce — §8;  $v_2$ 's Planck-order bounce density now matches his published numbers exactly).
  - ● **Diósi–Penrose objective collapse [genuine]**. ( $3'$ ) causal fixing is a **cousin** of DP, but triggered by a **Fisher information angle** ( $\Theta \geq \pi/3$ ), not gravitational self-energy — which is exactly why the DP  $\gamma$ -ray bound (Donadi et al. 2021) **does not constrain V131**.
  - ● **Weyl Curvature Hypothesis / CCC [analogy]**.  $C_6$ 's "initial low entropy = information reset" and "Big Bang = previous bounce" run parallel to Penrose's WCH/CCC — but the mechanisms differ (information phase transition vs conformal geometry); **analogy, not identity**.
  - **4D landing**. V131 is 9D but reduces to 4D (3+1) GR as  $\tau \rightarrow 0$  (B10); the Penrose/conformal 4D spacetime is V131's GR limit. **V131 doesn't replace 4D GR — it contains it as a limit**.
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**One-sentence summary ( $v_2$ ):** one set of equations — torsion repulsion replaces the Galactic-center singularity with a  $\sim 4 \times 10^{-21}$  m **torsion core** on a universal, carrier-free curve ( $10^{14}$  Planck lengths across;  $v_1$ 's "47 nm" is corrected on record), the potential and gradient of  $\Psi_{S01}$  deliver **dark energy** (thawing  $w(z)$ ,  $1.7\text{--}2.4\sigma$  from DESI vs  $4.2\text{--}5.8\sigma$  for  $\Lambda$ CDM, at the price of an owned one-way Hubble prediction  $H_0 \leq \Lambda$ CDM) and **dark matter** (Donato's universal  $140 M_\odot / \text{pc}^2$  becomes a theorem), a Planck-bounce freeze-out turns the baryon asymmetry into a **neutrino-mass prediction** ( $m_1 = 0.56$  meV, Majorana,  $\Sigma m_\nu \approx 0.059$  eV), and the exterior spacetime returns to GR ( $52.1$  vs  $51.8 \pm 2.3$   $\mu\text{as}$ ). Eleven falsification lines, all on the table.