The Bookkeeping of the Theater: Conservation, Circulation, and the Slow Spin of an Eternal Universe

Martin Scholl — Independent Researcher — It Is All One series, working paper

July 2026

It could not exist at all, and that would be fine. It exists, in this splendour, instead — and so it must keep books. — after the doctrine of līlā

Abstract

An eternal universe has no beginning to set its initial conditions and no end to absorb its debts; whatever it spends it must account for, forever. We present the complete bookkeeping of the exponential-infall cosmology developed in this series: four ledgers, each with its conservation principle, its formula, and its number. Ledger I (energy) is closed exactly by Noether's theorem — the static metric possesses a time symmetry, so the redshift is transfer between accounts and never a write-off; the expanding model has no such ledger. Ledger II (angular momentum) is opened by the quaternion screw's fixed handedness and balanced almost entirely internally: from the claimed galaxy-spin dipole $\varepsilon \approx 0.05$, the net angular momentum inside the horizon is $J \approx 10^{77}$ kg m^2 s^{-1}, giving the parent horizon a Kerr parameter $a^* \approx 6\times10^{-11}$ and an angular velocity $\Omega\_H \approx 2.8\times10^{-11}$ H — one revolution per 3×10^{21} years — landing a factor of three inside the CMB isotropy bound after ten orders of magnitude of exposure. Ledger III (entropy) is kept at the horizon: capacity $\sim2\times10^{122}$ k_B against a present inventory of $\sim3\times10^{104}$ k_B — blank pages for $\sim10^{18}$ Hubble times at the current rate of writing. Ledger IV (matter) never needs to close: the fall is asymptotic, black holes above 0.6 lunar masses are permanent in an eternal 2.725 K bath (they can never evaporate — a clean discriminator against the standard model), and the circulation — matter down, light up — maintains the disequilibrium that stars require. The universe of this series is not merely falling into a black hole; it is falling into one that turns, at a rate we compute, toward a surface that keeps its accounts.

1. Introduction: The View from Outside

Every mind that thinks about the universe stands, illegitimately and unavoidably, outside it. One pictures the four-dimensional quaternion spacetime of this series — its warm horizon, its black holes, its slow spiral — embedded like a mollusk pulsating in some neutral Cartesian cloud; one spools its time backward to explain and forward to predict. Physics grants no such vantage: there is no embedding space, no external clock, no stagehand's balcony. And yet the picture is not a mistake — it is the mind's method, and it earns its keep the moment it forces the right question. Seen from that imaginary outside, the theater below plays eternally. An eternal play cannot borrow: no opening-night endowment of low entropy, no final curtain to cancel its debts. Its books must balance in every act. The purpose of this paper is to open those books — four ledgers, each with its principle, its formula, and its number — and to show that the universe of this series keeps them, not by decree, but by symmetry, thermodynamics, and the patience of an asymptotic fall.

The framework is that of the preceding papers: the static exponential-infall metric with $1 + z = e^{(Hd/c)}$ (Paper on cosmology, with its explicit line element in the companion working note), the Tolman equilibrium $T(d) = T_0(1 + z)$ that makes the 2.725 K background the thermodynamic face of the curvature, the quaternion screw that converts infall into rotation with fixed handedness (paper on galaxy rotation), and the two horizons — the black holes' and the cosmological — as zeros of the same time component W (Paper 1). The doctrine of līlā supplies the epigraph but not the method. The method is Noether's.

2. Ledger I: Energy — Closed by Symmetry

Principle. A static metric is invariant under translation in time, and by Noether's theorem every continuous symmetry carries a conservation law. Time symmetry is energy conservation. The first equation of this paper is therefore the first equation of modern physics:

$$\partial g_{\mu\nu}/\partial t = 0 \Longrightarrow E = -p_\mu \xi^\mu = \text{const} \quad (1)$$

where ξ is the timelike Killing vector. For a photon this reads

$$h\nu(d) \cdot \sqrt{(-g_{tt}(d))} = \text{const}, \quad (2)$$

which is simultaneously the gravitational redshift and the Tolman law: frequency and temperature are the same bookkeeping.

Number. A photon leaves the photosphere at 3,000 K with characteristic energy ≈ 0.7 eV and arrives here at 0.64 meV. Its Killing energy at emission, 0.7 eV × (1/1101), equals its energy at reception exactly: the account transferred, to the last decimal, nothing written off. Contrast the expanding model, in which the background has lost 99.9 percent of its energy since last scattering and the honest answer to "where did it go?" is that it went nowhere — energy is simply not conserved there [Harrison 1995]. In this universe nothing is ever lost; it is only measured with deeper rulers. The energy cost of the entire background is likewise already audited (cosmology paper, Ch. 10): $u_{CMB}/\rho c^2 = 5\times10^{-5}$ of the matter's rest energy, against gravitational conversion efficiencies of 10^{-2}–4×10^{-1} — a budget with three orders of magnitude of headroom, now understood as maintenance margin for an equilibrium rather than fuel for a furnace.

3. Ledger II: Angular Momentum — The Rotation Budget

Principle. The screw of the galaxy-rotation paper has a fixed handedness (ij = k): it biases every conversion of infall into rotation the same way. If the ledger of energy is closed by time symmetry, the ledger of angular momentum is governed by axial symmetry — and a universe with a net handedness cannot be exactly spherically symmetric. The spherically symmetric line element of the working note is therefore the Schwarzschild-analogue idealization; consistency demands its Kerr analogue, with a $g_{t\varphi}$ cross-term: the universe's spin stored, as a black hole's is, in the geometry itself. Every black hole ever measured spins; the interior of one should be expected to inherit an axis.

The budget. Almost all of the screw's chirality is spent internally — galaxy against galaxy, a room of gyroscopes with only a slight common bias — so the global spin is the small residual of enormous local activity:

$$J = \varepsilon \cdot N_{gal} \cdot \bar{J}_{gal} \quad (3)$$

With the claimed spin-handedness dipole $\varepsilon \approx 0.05$ [Longo 2011; contested — Land et al. 2008 find null; the result below scales linearly in ε], $N_{gal} \approx 2\times10^{11}$, and $\bar{J}_{gal} \approx 10^{67}$ kg m^2 s^{-1} (a Milky-Way-scale disk):

$$J \approx 1\times10^{77} \text{ kg m}^2 \text{ s}^{-1}.$$

The parent hole has $M = c^3/2GH = 8.9\times10^{52}$ kg and $r_s = c/H$, so

$$a^* = Jc/GM^2 \approx 6\times10^{-11}, \; \Omega_H = a^*\cdot H/2 \approx 2.8\times10^{-11} \, H \approx 6.5\times10^{-29} \text{ rad s}^{-1}. \quad (4)$$

Numbers, plainly. One revolution of the cosmological horizon every 3×10^{21} years — 2×10^{11} Hubble times per turn; a twist of 1.6×10^{-9} degrees per Hubble time; and in the algebra's own units, the unit quaternion (double cover) advancing at $\Omega/2 \approx 1.4\times10^{-11}$ H. Two placements of this number matter (Figure 2). First: the CMB isotropy bound on solid-body rotation is $\Omega/H \lesssim 10^{-10}$, and the estimate lands a factor of $\sim$3 inside it — after ten orders of magnitude of room to fail. Second: the naive screw scale $H/2e \approx 0.18$ H is excluded by nine orders — which is precisely the statement that the chirality is almost entirely internal, as the gyroscope-room picture requires.

Where the spin "dissolves" at the horizon: it does not. Three vantages, three answers. To us, it freezes: any angular velocity there is throttled by the lapse, $\Omega_{obs} = \Omega\cdot\sqrt{(-g_{tt})} \to 0$ — the turning wall appears eternally still. In itself, it rigidifies: by the rigidity theorem a stationary horizon rotates as a rigid body, Ω_H uniform across the surface, its null generators corkscrewing at fixed pitch — the one solid-body rotation in the universe, the screw cap turning as a piece. To physics inside, it Machifies: within a rotating shell the frame dragging is uniform, so local inertial frames partially corotate and no local experiment feels it — we in the middle feel nothing, as required. What survives observationally is cumulative and statistical: the spin-handedness dipole itself, the alignment of the CMB's largest multipoles, and — if it is metric in origin — cosmic birefringence.

One recorded tension. If the claimed isotropic birefringence ($\beta \approx 0.3°$) were metric twist accumulated along the path from the photosphere, it would require $\omega \approx 7\times10^{-4}$ H — eight orders above the budget of equation (4). If both signals are real, they cannot both be the horizon's rotation; either the birefringence belongs to the tension medium's own optical activity (or an axion-like field), or the spin dipole is grossly underestimated. The decisive observation is the coherent-axis test: the galaxy-spin dipole, the CMB multipole alignment, and the birefringence axis must coincide if the chirality is cosmologically coherent — and must not, if it is noise.

4. Ledger III: Entropy — Kept at the Horizon

Principle. The one quantity that grows in any working theater is disorder, and an eternal universe must bank it somewhere or die the heat death. The account exists: horizon entropy,

$S_{hor} = k_B \cdot A/4\ell_p^2 = k_B \cdot \pi R^2/\ell_p^2$, $R = c/H$. (5)

Numbers. $S_{hor} \approx 2\times10^{122}\, k_B$. The present entropy inventory of the observable universe — dominated by supermassive black holes — is $\approx 3\times10^{104}\, k_B$ [Egan & Lineweaver 2010], produced over roughly a Hubble time. At that writing speed the ledger has of order 10^{18} Hubble times of blank pages, and the surface it is written on is asymptotic — approached forever, never reached, never full. Entropy flows down the well with everything else and is absorbed into the one account that cannot saturate. That horizons keep thermodynamic books is not this paper's invention; it is the established result of Bekenstein, Gibbons–Hawking, and the emergent-gravity tradition this series already cites — here it is simply, at last, used for what an eternal cosmology needs it for.

5. Ledger IV: Matter — The Circulation That Never Closes

The drain is nearly plugged. The N-body work of the galaxy-rotation paper found, as numerical fact, what the algebra implies: the screw grips infall and goes dormant on circular orbits. Once matter circulates, the screw has nothing to convert; orbits conserve their angular momentum superbly, and the spiral arms are patterns matter flows through, not channels it flows down. The local drain runs only on friction — gas that cools and sinks — which is why a galaxy can be a drain and last forever.

Black holes are permanent. In an eternal 2.725 K bath, a black hole is a net absorber whenever its Hawking temperature lies below the bath's:

$T_H = \hbar c^3/8\pi G M k_B < 2.725\text{ K} \Leftrightarrow M > 4.5\times10^{22}\text{ kg} \approx 0.6$ lunar masses. (6)

Every astrophysical black hole is therefore permanent: it will never evaporate, because the sky will never grow colder than it. This is a clean structural discriminator against the standard model, where the cooling background eventually falls below every hole's temperature and evaporation wins. Consequence: any confirmed detection of a Hawking final-burst — the terminal flash of an evaporating primordial black hole — falsifies the eternal-bath cosmology outright. The absence of such bursts to date is, for this model, the expected silence.

The circulation. What, then, balances? Matter descends — into black holes at accretion efficiency $\eta = 0.06$–0.42, through stars at 0.007, and always, asymptotically, toward the depth. Light ascends: the accretion glow of the quasars, starlight, and the Flimmer of the deep wall itself. The steady-state condition is a throughput balance,

$$L\_up = \eta \cdot \dot{M}\_down \cdot c^2, \quad (7)$$

and it governs the *disequilibrium* — the continued existence of stars and structure — not the bath, which as Tolman equilibrium needs no feeding at all. Deriving $\dot{M}$_down from the screw and checking equation (7) against the integrated glow of the universe is the one calculation of this paper left explicitly open; it is well-posed, and it is the natural sequel. Deeper than the balance, though, lies the gentlest entry in all four ledgers: the matter account never actually needs to close. The journey is asymptotic; the singularity is approached forever and arrived at never; a play whose first act has no end requires no scheme for the interval. Birth and death equal out not because a mechanism enforces it moment by moment, but because the approach to balance is itself the play.

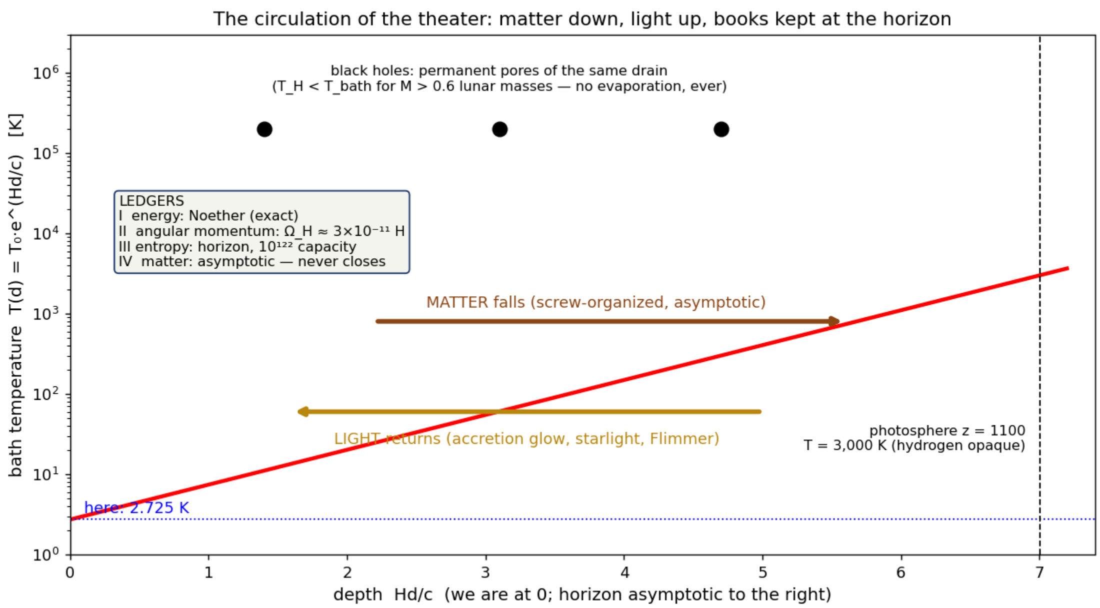

Figure 1. The circulation of the theater. The Tolman profile (red) sets the temperature at every depth; matter descends (screw-organized, asymptotic), light returns (accretion glow, starlight, Flimmer), black holes are permanent pores of the same drain, and the four ledgers are kept as marked.

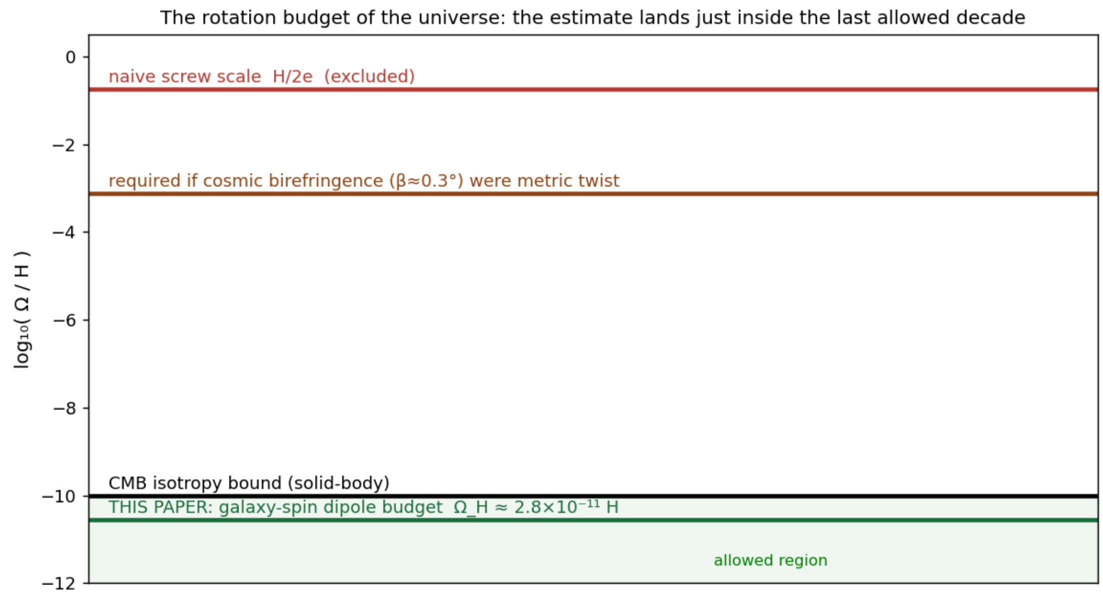

Figure 2. The rotation budget on a logarithmic ladder. The naive screw scale is excluded by nine orders; the galaxy-dipole budget of equation (4) lands a factor of three inside the CMB isotropy bound; the birefringence signal, if metric, would sit eight orders higher — the recorded tension of Section 3.

6. Discussion: The Mollusk and Its Books

Seen again from the mind's imaginary outside — the pulsating four-dimensional mollusk in its neutral cloud — the theater now carries its account-book visibly. Nothing about its balance is imposed. The energy ledger closes because the geometry is static (Noether). The angular-momentum ledger carries a small, computed, fixed-handed residual, stored in the metric as every black hole stores its spin, turning once in three sextillion years, just inside the bounds the sky has set. The entropy ledger is kept by the horizon, with room for a billion billion Hubble times of further play. The matter ledger never closes and never needs to: asymptopia is the accountant of last resort. And the whole structure is falsifiable at named points — the coherent-axis test, the spin dipole, the permanence of black holes against any future Hawking burst, the 21-cm null of the cosmology paper.

The doctrine of līlā says the play needs no purpose; physics adds only that it needs consistent books. It could not exist at all, and that would be fine. It exists instead in this splendour — self-accounting, slowly turning, warm at 2.725 kelvin, its debts deferred to a surface that will never present the bill.

Open Problems

(i) The throughput calculation of equation (7): Ṁ_down from the screw against the integrated cosmic glow. (ii) Metric D_a: the g_tφ generalization of the line element, its required source (the pre-tensed medium becoming pre-torqued), and the predicted dipole amplitude as a function of ε. (iii) A measured ε: the spin-handedness dipole with modern bias control, the single number on which Ledger II rests. (iv) The coherent-axis test across the three claimed anomalies. (v) The entropy current: a formal statement of dS/dt flowing to the horizon account in the static metric.

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