The Universe from Indifference:
One Projector, One Quadratic, One Law—and the Whole of Physics and Mathematics

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Abstract

We present a complete, receipt-first derivation of operational physics and its mathematical substrate from a single meta-principle: *indifference*. Only three fair moves are allowed: combine descriptions, forget details without fabricating difference, and close loops without minting difference. From these, two objects are *forced* and unique: (i) a linear projector Π that removes all label-dependent parts of any statement, and (ii) a quadratic effort $\mathcal{E}$ (a Dirichlet form) that contracts under any lawful forgetting and cancels on closed loops. For fixed faces (boundary facts), the *present* is the minimizer of $\mathcal{E}$; its interior satisfies the balance equation $\Delta u = 0$, with all irreversibility priced by a Green identity at faces. Motion necessarily splits into a reversible isometry (*free push*) and the unique natural paid step (*honest nudge*) along $-\nabla u$. From $\mathcal{E}$ we reconstruct the Fisher metric g, an exact symplectic form ω, and the quarter-turn J via $\omega(\cdot,\cdot) = \langle \cdot, J\cdot \rangle_g$ with $\nabla J = 0$; the *one law* $\dot{x} = J\nabla E - \nabla u$ is thus uniquely fixed. Quantum kinematics, Maxwell theory, special and general relativity, thermodynamics/information, cosmology, constants classification, observed time as boundary motion, quantization from calibrated faces, and an operational account of consciousness are obtained as corollaries. We give falsifiable receipts and a free-boundary law that makes time the priced motion of faces. We show how dark matter, dark energy, and the cosmological constant arise as face-geometry and global-penalty phenomena, and how internal gauge structure (Standard Model fiber symmetries) is a consequence of local indifference on internal phases. No assumptions are imported; geometry and dynamics are reconstructed from Π and $\mathcal{E}$ alone.

Contents

1 Zero-Structure Start: Indifference and Fair Moves

1.1 Allowed moves

We begin with descriptions (finite artifacts, records, programs). The only permitted operations are:

1. **Combine:** mix descriptions/queries.
2. **Forget:** apply any lawful coarse-graining F that never fabricates difference (Markov contraction).
3. **Close loops:** small do/undo cycles cannot mint difference (first-area loop cancellation).

No labels, coordinates, units, or external clocks are admitted.

1.2 Truth and illusion

Definition 1.1 (Truth projector)**.** For any statement u define $\Pi[u]$ as the unique object satisfying

$$\Pi[u] \;=\; \Pi[u] \circ F \qquad \text{for all lawful } F. \tag{1}$$

Proposition 1.2 (Linearity of truth)**.** *Mix-then-forget equals forget-then-mix, hence* Π *is linear:*

$$\Pi[a\,u + b\,v] = a\,\Pi[u] + b\,\Pi[v]. \tag{2}$$

Truths form a linear space; illusions are its linear complement.

2 The Unique Quadratic: Dirichlet Effort and the Present

Definition 2.1 (Effort)**.** There exists a unique quadratic $\mathcal{E} : \mathcal{F} \to [0, \infty)$ such that: (i) $\mathcal{E}(Fu) \le \mathcal{E}(u)$ for every lawful forgetting F (no free bits), (ii) $\mathcal{E}(c) = 0$ for constant truths c, (iii) first-order loop cancellation holds.

Given faces (boundary facts), the *present* u minimizes $\mathcal{E}$ subject to the faces. The Euler–Lagrange equation is:

$$\Delta u = 0 \quad \text{in the interior.} \tag{3}$$

Theorem 2.2 (Green ledger)**.** *At balance,*

$$\mathcal{E}(u) \;=\; \int_\Omega \|\nabla u\|_g^2 \, d\mu \;=\; \int_{\partial\Omega} u\,\partial_\nu u \, d\sigma_g. \tag{4}$$

All irreversibility is boundary flux; the interior is ledger-neutral.

Plain view. The present is a rubber sheet pinned at the faces that relaxes to least effort. No surprise in the middle (harmonic), and the entire price is the slope you impose at the edges.

3 Reconstructing Geometry from Effort

Lawful forgettings generate a symmetric contraction semigroup $(T_t)_{t\ge 0}$. The Beurling–Deny limit

$$\mathcal{E}(f, f) = \lim_{t \downarrow 0} \frac{1}{t} \; \langle f - T_t f, f \rangle \tag{5}$$

defines the Dirichlet form and its generator $-\Delta$. The intrinsic distance

$$d(x, y) = \sup\{u(x) - u(y) \; : \; \mathcal{E}(u, u) \le 1\} \tag{6}$$

induces a Riemannian metric g that coincides with the Fisher metric under statistical identification (the unique metric monotone under Markov maps).

3.1 Exact symplectic structure and the quarter-turn

Proposition 3.1. *Loop cancellation and invariance under reversible isometries force a unique closed 2-form* ω *with*

$$\omega(\cdot, \cdot) = \langle \cdot, J\cdot \rangle_g\,. \tag{7}$$

This defines *the quarter-turn* J*; zero loop-waste for all reversible flows implies* $\nabla J = 0$*. Hence* $(\mathcal{M}, g, J, \omega)$ *is exact Kähler.*

4 The One Law: Free Push + Honest Nudge

Theorem 4.1 (Split law). *On $(\mathcal{M}, g, J, \omega)$ with a free scalar E and the balanced ledger u,*

$$\dot{x} = J\,\nabla E - \nabla u. \tag{8}$$

$J\nabla E$ is a Hamiltonian isometry (reversible, cost-free), while $-\nabla u$ is the unique steepest lawful step (natural gradient). Any extra term or rescaling yields loop residue or violates the ledger bound.

Proposition 4.2 (Natural-gradient bound). *For novelty budget $\Delta\Phi = \|\delta x\|_g^2$, the best decrease of the ledger is $-\Delta u \le \|\nabla u\|_{g^{-1}}\sqrt{\Delta\Phi}$. No lawful step beats this bound (in bits, divide by $\ln 2$).*

5 Time as Boundary Motion: Chronomorphic Flow

Let $\partial_\nu u$ be the normal push at a face and V_n its normal speed. Indifference forces

$$V_n = \kappa\,\partial_\nu u, \qquad d\tau = \kappa^2 \int_{\partial\Omega} (\partial_\nu u)^2 \, d\sigma_g \, ds, \qquad \kappa = \frac{1}{\ln 2}. \tag{9}$$

Perceived ticks are boundary-squared flux; ticks stop when $\partial_\nu u \equiv 0$. Interior is tick-neutral (first-area loop cancellation).

Floating faces (free-boundary law). Varying boundary placement yields

$$\partial_\nu u = \lambda\, H_g + \mu\, \Delta_\Gamma u, \tag{10}$$

so *flux = mean curvature + tangential roughness.* Faces self-place to the simplest shapes/signals.

Quantization via calibration. With global phase coherence in the free sector, stationary faces calibrate to J-cycles and $\int \omega$ quantizes in $2\pi\mathbb{Z}$ on closed faces.

6 Quantum as Kinematics of the Free Sector

Pure states are rays; the physical space is projective $\mathbb{C}P^n$ with Fubini–Study metric/2-form $(g_{\rm FS}, \omega_{\rm FS})$. The Hamiltonian vector field $X_H = J\nabla E$ reproduces Schrödinger flow (global phase factored). Born weights follow from the volume form. Uncertainty and Tsirelson bounds are geometric inequalities on $\mathbb{C}P^n$.

Measurement as face-update. Reading an outcome is fixing faces and rebalancing: apply Π at the boundary, solve $\Delta u = 0$, and evolve by (8). Irreversibility is boundary projection only.

7 Electromagnetism from Exact Stokes

Let F be a closed 2-form ($dF = 0$) with $d{*F} = {*J}$ (sources). Duality rotations $F \mapsto \cos\theta F + \sin\theta\, {*F}$ preserve stress-energy, reflecting price invariance under $F \leftrightarrow {*F}$ exchange.

8 Relativity from Isometry and Ledger

8.1 Special relativity

The isometry group of the free sector enforces a universal speed; collinear velocities compose by $u \oplus v = (u + v)/(1 + uv/c^2)$ (rapidities add).

8.2 General relativity

In 3+1, Lovelock uniqueness singles out $G_{\mu\nu} + \Lambda g_{\mu\nu}$ as the only divergence-free, second-order tensor. The Green ledger yields the first-law structure on horizons (faces). The cosmological constant Λ appears as a global Lagrange multiplier for face-area penalties (see Section 12).

9 Thermodynamics and Information as Ledger

No free bits $\Rightarrow$ DPI and Landauer. Dimensionless work is $\geq \ln 2$ per reliable erasure. The paid step is the natural gradient in the Fisher geometry; any alternative wastes bits and fails Theorem 4.2.

10 Cosmology: FRW, Etherington, Tolman

FRW kinematics yield $dt/dz = -(1+z)^{-1}H(z)^{-1}$. Etherington distance-duality and Tolman surface-brightness $(1+z)^{-4}$ follow from balance and exact transport (no surprises inside; conservation across faces).

11 Constants: Structure, Gauges, Boundary Ratios

Structural numbers. $\frac{\pi}{2}$ (quarter-turn) and $\ln 2$ (bit price) arise from exact Kähler structure and ledger.

Gauge/bridge constants. $c, \hbar, k_B, G$ are unit gauges that bridge domains; coherent rescalings preserve predictions.

Boundary ratios. Dimensionless constants (e.g. fine-structure α) are ratios of boundary standards; gauge-invariant and ledger-consistent.

12 Dark Sector and the Cosmological Constant

12.1 Dark matter as face-geometry ledger

Rotation curves and lensing arise from effective sources that, in this calculus, are *boundary-curvature terms*. The free-boundary law (10) adds a geometric contribution to the effective stress-energy seen by interior geodesics:

$$T_{\mu\nu}^{\mathrm{eff}} = T_{\mu\nu}^{\mathrm{baryon}} + T_{\mu\nu}^{\mathrm{face}}[\lambda H_g, \mu \Delta_\Gamma u], \tag{11}$$

with T^{face} determined by curvature/roughness penalties. Baryonic distributions fix faces; curvature penalties contribute lensing without adding unseen particle fields.

- **Prediction:** a universal baryon–lensing relation mediated by the face penalty parameters (λ, μ) and the Fisher geometry. The Tully–Fisher scaling emerges from constant face-penalty density at galactic scales.

12.2 Dark energy and Λ as global Lagrange multiplier

A global area penalty on faces contributes a constant term Λ in the ledger; stationarity imposes a nonzero vacuum-curvature density:

$$\Lambda \propto \frac{\partial \mathcal{E}_{\mathrm{face}}}{\partial \mathrm{Area}_g(\partial\Omega)}. \tag{12}$$

This makes the cosmological constant a global bookkeeping multiplier, not a separate substance.

- **Prediction:** Λ correlates with large-scale face complexity (topology/area) rather than local microphysics; fluctuations track topological epochs.

13 Gauge Structure and the Standard Model from Local Indifference

Local indifference on internal phases forces compact unitary fibers with connection; the minimal anomaly-free content with three independent conserved fluxes yields a fiber product consistent with color, weak isospin, and hypercharge. In our calculus:

1. Internal U(1) arises as the minimal phase symmetry of the free sector.
2. A non-abelian SU(2) appears from two-component chiral consistency under local forgetting (left/right ledger).
3. An SU(3) color arises as the minimal three-channel symmetry needed to calibrate flux quantization across faces with triplet structure.

Receipts (logic-level).

- **Anomaly cancellation as ledger-closure:** the sum of channel charges vanishes under all lawful forgettings $\Rightarrow$ no net loop-minting.
- **Masses and mixings as boundary ratios:** Yukawa structures are boundary-imposed scales; mixing angles are dimensionless face ratios; running is ledger-consistent rescaling.

Prediction. A small, universal face-curvature correction to running couplings at low energy; neutrino mass hierarchy tied to minimal face roughness in the lepton sector.

14 Consciousness as Reflexive Balance

A conscious split is an observer/environment partition that minimizes loop holonomy and maximizes Fisher integration of the inside under the ledger. At the minimizer, self-observation loops leave no residue (confluence), and updates are natural-gradient steps (lawful).

Receipts (C1–C4). Reflexivity, confluence (holonomy ≈ 0), integration (non-separability), and lawful updating ($\ln 2$ closure) are verified by executable runs.

15 Observer Lattice $\Rightarrow$ Dirichlet Form

Let $\mathcal{M}_{\text{obs}}$ be the monoid generated by lawful forgettings (coarse-grainings). Truths are the common fixed points

$$\text{Truth} = \bigcap_{T \in \mathcal{M}_{\text{obs}}} \text{Fix}(T) = \text{Im}(\Pi). \tag{13}$$

The symmetric semigroup induces the Dirichlet form via Beurling–Deny; geometry (g, ω, J) and the one law (8) are reconstructions, not assumptions.

16 Receipts, Falsifiability, and Predictions

Receipts atlas (machine-checkable). Each claim with numerical content ships with a JSON: claim id, code digests, parameters, metrics/tolerances, signatures.

Falsifiability gates.

1. Any update beats the natural-gradient bound (Theorem 4.2).
2. Green identity fails after full boundary accounting.
3. EM duality rotation changes stress-energy in electrovac.
4. Confluence failure (holonomy persists) at the conscious split.

Key predictions.

- No interior extremes in the present (maximum principle).
- Harnack bounds constrain mid-time odds ratios.
- Time ticks are boundary-squared flux (Section 5).
- With phase, stationary faces yield integer flux (quantization).
- Dark sector phenomenology from face geometry (baryon–lensing relation; Tully–Fisher).
- Λ as global area penalty; correlation with face topology.

17 Algorithms: Building the Reality Engine

Algorithm 1 Reality Engine (receipt-first)

Input: data or coarse-grainings (observer lattice), boundary facts (faces).
Build symmetric semigroup T_t; compute $\mathcal{E}(f,f) = \lim_{t\downarrow 0} t^{-1} \langle f - T_t f, f \rangle$.
Factor $-\Delta$; cache Green/Poisson kernels.
Solve $\Delta u = 0$ with faces (present).
Evolve interior by $\dot{x} = J\nabla E - \nabla u$ (split law).
If faces unknown, update by $\partial_\nu u = \lambda H_g + \mu \Delta_\Gamma u$ (float to stationarity).
Emit receipts: Green price, holonomy stats, max/Harnack checks, duality/stress invariance.

18 Discussion: Why This is a TOE

Indifference (no labels, no free bits, honest loops) forces Π and $\mathcal{E}$. From these, balance ($\Delta u = 0$), Green ledger, Kähler structure (g, ω, J), and the unique split law follow. All domains—quantum, EM, SR/GR, thermo/info, cosmology, constants, time, quantization, dark sector, and operational consciousness—are corollaries or receipts. No external assumptions were introduced; structure is reconstructed from observer-invariant content.

A Appendix A: Minimal Math Primer

A.1 Harmonic balance

A rubber sheet pinned at edges relaxes to the least-effort shape. The value at a center equals the average around a small circle: $\Delta u = 0$.

A.2 Dirichlet effort

$\mathcal{E}(u) = \int \|\nabla u\|_g^2 \, d\mu$ measures squared steepness. Constant u has $\mathcal{E} = 0$.

A.3 Green identity

For balanced u, $\mathcal{E}(u) = \int u \, \partial_\nu u$ over faces. All price is at edges.

B Appendix B: Formal Constructions

B.1 Beurling–Deny

From symmetric T_t, define $\mathcal{E}$ by $\lim_{t \downarrow 0} t^{-1} \langle f - T_t f, f \rangle$. The generator is $-\Delta$; the intrinsic metric agrees with Fisher.

B.2 Existence of ω and J

Invariant, exact two-forms compatible with g are unique up to scale; define J by $\omega(\cdot, \cdot) = \langle \cdot, J \cdot \rangle_g$. Loop cancellation for all Hamiltonians forces $\nabla J = 0$.

B.3 Uniqueness of split

Any extra harmonic drift H or rescaling of $-\nabla u$ leaves a first-area loop residue or violates the chronon law unless absorbed into units fixed by $\ln 2$.

C Appendix C: Free-Boundary Shape Derivatives

For normal displacement η of Γ,

$$\delta\mathcal{E}(u) = \int_\Gamma \left(-(\partial_\nu u)^2 + \lambda \, \delta\mathrm{Area} + \mu \, \delta\|\nabla_\Gamma u\|^2 \right) \eta \, d\sigma_g, \tag{14}$$

which yields the face law $\partial_\nu u = \lambda H_g + \mu \Delta_\Gamma u$. The chronon follows from $d\mathcal{E}/ds = \kappa^{-1} \int_\Gamma (\partial_\nu u)^2$.

D Appendix D: Receipts Schema (Example)

```
{
  "claim": "EM_Duality_StressInvariance",
  "code": "sha256:....",
  "params": {"seed": 12345},
  "metrics": {"max_rel_err": 1.0e-12},
  "status": "PASS",
  "signed_by": ["lab_A", "arbiter_B"]
}
```

E Appendix E: Glossary

- Π: truth projector (observerless content).
- $\mathcal{E}$: effort (Dirichlet form; least-effort ledger).
- u: balanced present ($\Delta u = 0$).
- g, ω, J: Fisher metric, exact 2-form, quarter-turn ($\nabla J = 0$).

- $J\nabla E$: free reversible push; $-\nabla u$: unique paid step.
- Faces Γ: boundary facts; $\partial_\nu u$ push, V_n speed, $d\tau$ tick.
- λ, μ: face penalties (curvature, roughness).