The Selective Transient Field from First Principles — The Two-Clock Theory

The two-clock theory, its conditional gravitational completion, and the frozen timing-response prediction — Backbone Edition: the theory as it now stands, at its exact grades, with every derivation delegated to the published Verification Record

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The Two-Clock Theory, Its Conditional Gravitational Completion, and the Frozen Timing-Response Prediction

Version 9.6.1 — Backbone Edition — 1 September 2026

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This paper is the reader-facing statement of the STF programme as it stands at the frozen v9.6.1 release together with the Study 19–20 composition discrimination and its completion. Every result below is established in a machine-verified record: the complete, hash-pinned release chain — over thirty-three million checker assertions — is preserved as the STF First Principles Verification Record, referenced in §X. The paper states results at their exact grades; the record verifies them.

Abstract

The Selective Transient Field (STF) is a scalar-response framework organized around two temporal objects: a universal ordering field and an internal cyclic phase. The distinction is forced by the gradient-clock obstruction: an oscillatory scalar amplitude cannot serve as a normalized-gradient clock, because its gradient vanishes at every turning point and therefore cannot carry a continuous global ordering. STF consequently uses a universal scalar T_U, with future-directed unit normal

$$N_\mu = -\frac{\nabla_\mu T_U}{\sqrt{-\nabla T_U \cdot \nabla T_U}}, \qquad D_U = N^\mu \nabla_\mu,$$

and a distinct internal phase $\Theta_I \in S^1$. Universal time orients causal response and the clock-relative curvature decomposition; the internal phase labels the field cycle. What the framework's prior ontology held as a distinction, the obstruction proves as a theorem. **[theorem]**

The theory's response sector is built on the positive clock-relative curvature state $q_N^2 = R^2 + 8\mathcal{W}_N$, an exact causal high-pass memory with a single Drude turnover, and the regulated compact readout $Q_\Delta = M_*^2(\sqrt{q_N^2 + \Delta^2} - \Delta)$. Its numerical timing structure retains exact provenance: observation supplied the 3.32-year and 71-day anchors; the emission-window closure supplied the approximately 54-year outer anchor conditionally; the Peters a^4 law translates the three times into the 1466, 730, and 360 R_S separation images. None of these numbers is treated as rigid, and none is used to solve a theoretical coefficient or select a model element. **[provenance discipline]**

The gravitational sector is a conditional completion, audited rather than assumed. A five-gate adversarial audit, two frozen consolidations of thirteen calculation records, a fifty-one-gate covariant architecture programme, and eleven comparative gravity lift studies establish, among their results: a constructive non-identifiability theorem for the previously symbolic compact response port; an explicit eleven-component completion amendment that passes the resulting contract on the radial classical branch with one dyadic coupling chosen inside a derived stability window and zero timing input; a stable compact baseline spectrum on a finite relational phase star, with fundamental $\omega_0 R = 0.1889913902$; and a same-port positivity theorem for every closed Hermitian sub-fundamental response. Four withdrawals, one declared tuning, and two branch suspensions from the gate chain are retained in the record; nothing is deleted. The controlling grade is unchanged throughout:

$$\boxed{\text{STF is a coherent gravitational candidate — not a completed gravity theory.}}$$

On this architecture the programme reaches its first frozen prediction. The selected source branch fixes the onset law $\tau_{\rm src} = C\,\mathcal{R}^{-8/5}$ for rigidity $\mathcal{R}$; charged small-angle transport contributes $\Delta_{\rm mag} = A\,\mathcal{R}^{-2}$; and the detector lead $L = \tau_{\rm src} - \Delta_{\rm mag}$ admits the exact affine representation

$$X = \mathcal{R}^{2/5}, \qquad Y = \mathcal{R}^2 L, \qquad \boxed{Y = CX - A.}$$

Two rigidity-resolved events from one source episode determine both nuisance coefficients; every further event is a prediction with no refit permitted. The normalization closure derives both coefficients as functions of independently measurable inputs — source capacity physics for C, with a remote-converter lift $C_{\rm rem} = C_{\rm loc}\,\mathcal{F}^{8/5}$, and line-of-sight magnetics for A — so that, once a measured-input dossier exists for a real source, every event is predicted with no timing calibration at all. The prediction protocol is preregistered and frozen: eligibility contract, immutable calibration split, rejection thresholds, and a forbidden-refit list that bars every escape route.

A first retrospective data confrontation is on record. The 494-event Auger population behind the observational programme, now provenance-pinned to the public Auger Open Data release, was propagated event by event through both normalization branches' implied nuclear-charge windows and confronted with published Auger composition measurements. The verdict is **remote favored, with no branch exclusion**: the local branch demands charges predominantly above iron, while the remote branch at its reference lift $\mathcal{F} = \sqrt{5}$ implies an intermediate oxygen-through-silicon charge window, overlapping the nitrogen-group support that dominates Auger's measured composition at these energies — and this is the same energy population in which the framework's own energy-stratified timing tests found the signal. The consistency is retrospective, not blind, and it is conditional on the reference value of $\mathcal{F}$, which is now the theory's most exposed quantity: the retrospective structure is robustly consistent for $\mathcal{F}$ between roughly 1.6 and 29, and robustly broken below 0.7; the frozen reference sits inside the consistent band, while the closest simulation-leaning values straddle the broken and indeterminate zones. The programme's empirical status is therefore prediction-ready and conditionally falsifiable; the response law's remaining freedom is measurement, not algebra.

I. Introduction

I.A Discovery first, reconstruction second

The STF programme began as an observational result, not a theory. A statistical programme over public ultra-high-energy cosmic ray, gamma-ray burst, and gravitational-wave catalogs [15,16] returned a temporal structure — a 3.32-year period, a 71-day window, and an approximately 54-year activation horizon — together with a curvature exponent. The first STF Lagrangian was written to express what those data contained. That discovery record is the observational manuscript [11] and the Test Authority validation document [12]; its event population is the Pierre

Auger Observatory public dataset, 2004–2018, with the cut $E > 20$ EeV and zenith below 80°: 494 unique events.

The theoretical reconstruction then asked whether the observationally found anchors and phenomenological coefficients could be removed from the Lagrangian's input list and recovered from General Relativity, topology, compactification [9], and causal response. The project-paper chain on which the reconstruction relies is part of the record [1–10]: *Theory of Time* [2] supplies the universal/local temporal distinction; *The Structure of What Happens* [3] supplies the universal-history/local-measurement framework; *Framework Guide* [4] records the framework-wide dependency and claim discipline; and *First Principles* V7.9 [1] remains the derivation record for downstream sectors where this paper expressly delegates to it.

I.B The dependency discipline

A quantity is a *prediction* only if the calculation producing it does not use the observation against which it is tested. A quantity is a *calibration* if it does. A quantity is a *validation* if an independent calculation reproduces an observation it did not use. A *discovery* is the empirical route by which the pattern was first found; later reconstruction does not erase that history. The gravitational audit added three further grades: an *existence construction* proves that at least one parent with a stated property exists; a *conditional bridge* supplies no prediction until its conditions and coefficients are independently fixed; and a *closed* or *superseded* realization remains in the record rather than being silently removed. These rules bind every claim in this paper. Where a past claim was corrected, the correction and the superseded statement are both preserved: in this programme, withdrawal is a status, never a deletion.

I.C How to read this paper

This edition tells the theory once, in a single voice, at its current state. It does not re-derive; it states each result with its grade and delegates every derivation to the machine-verified release chain summarized in §X — the Verification Record [13] — which preserves, byte-intact and hash-pinned, every version of this paper's technical predecessor, all calculation records, all checkers, and all negative results. Readers who want to audit rather than read should start there: the record's packages verify their own checksums, rerun their assertions, and regenerate their results byte-identically on any machine with Python and NumPy.

Two statements about scope, made once so the rest of the paper can be positive. First, nothing here claims a completed quantum theory of gravity; the boxed grade above is controlling everywhere. Second, nothing here claims a blind empirical validation; the known timing anchors were available to every session that built the comparators, all data confrontations to date are labeled retrospective, and the one genuinely blind instrument — the preregistered held-out multiplet test of §VII — has not yet met a qualifying sample.

I.D Notation and units

SYMBOL	MEANING	UNITS / CONVENTION
T_U	universal ordering scalar	arbitrary future-preserving monotone label
$N_\mu,\ D_U$	unit normal to T_U; universal derivative $N^\mu \nabla_\mu$	defined where ∇T_U is timelike
Θ_I	internal cyclic phase	radians on S^1
q_N	clock-relative curvature norm state, $q_N^2 = R^2 + 8\mathcal{W}_N$	curvature (length^{-2})
$Q_\Delta,\ M_*,\ \Delta$	regulated compact readout; declared scale and regulator	frozen architecture parameters
$\omega_c,\ \tau_c$	Drude turnover frequency and time	$\tau_c = 0.529$ yr
E	event energy	EeV $= 10^{18}$ eV
Z	nuclear charge number	dimensionless
$\mathcal{R}$	magnetic rigidity, $\mathcal{R} = E/Z$	**EV (exavolt, 10^{18} V) — not eV**; numerically $E[\mathrm{EeV}]/Z$
$\tau_{\mathrm{src}},\ \Delta_{\mathrm{mag}},\ L$	source onset, magnetic delay, detector lead	days before merger
C	source normalization, $\tau_{\mathrm{src}} = C\,\mathcal{R}^{-8/5}$	days at $\mathcal{R} = 1$ EV

SYMBOL	MEANING	UNITS / CONVENTION
A	transport coefficient, $\Delta_{\rm mag} = A\,\mathcal{R}^{-2}$	days at $\mathcal{R} = 1$ EV
$\mathcal{F}$	remote-converter lift, $C_{\rm rem} = C_{\rm loc}\,\mathcal{F}^{8/5}$	dimensionless
$\beta_{\rm EGMF}$	$(B/\mathrm{nG})\sqrt{L_c/\mathrm{Mpc}}$	dimensionless field–coherence combination
$X,\ Y$	affine coordinates $X = \mathcal{R}^{2/5}$, $Y = \mathcal{R}^2 L$	EV$^{2/5}$; EV^2·days

II. The Two-Clock Foundation

II.A The gradient-clock obstruction

If an oscillatory scalar amplitude $\phi = A\cos\Theta_I$ is used as a normalized-gradient clock, its gradient vanishes at every turning point; a periodic amplitude therefore cannot provide a continuous global ordering. This is the gradient-clock obstruction, and it forces the framework's central structural decision: the internal cyclic phase and the universal ordering cannot be the same object. **[theorem]**

STF therefore carries two temporal structures. The universal scalar T_U defines, wherever its gradient is timelike, the future-directed unit normal N_μ and the universal derivative $D_U = N^\mu \nabla_\mu$; it orients causal response and the clock-relative decomposition of curvature. The internal phase $\Theta_I \in S^1$ records where the field lies in its cycle; the amplitude is a local half-cycle chart of the clock, never its global coordinate. **[definition]** Because N^μ is hypersurface-orthogonal, its own vorticity vanishes by Frobenius: the universal clock supplies ordering, not rotation. **[definition]**

The framework's prior ontology already held these roles separate: *Theory of Time* [2] states universal time as an ontologically real, globally coherent temporal background that local systems reference while creating their own time; *The Structure of What Happens* [3] makes the same operational separation between the universal history and the internal clocks by which a subsystem measures it. The obstruction promotes that ontology to a theorem of the field representation. Conditional on a global phase lift and dynamical synchronization, universal time may be represented by an unwrapped phase and internal time by its cyclic projection, the covering map $\mathbb{R} \to S^1$ — the carrier of T_U being its own open construction [10]; that is a completion, not the theorem. **[theorem/entailment]**

II.B Clock-rate invisibility and the observation map

Because N^μ depends on T_U only through its normalized gradient, it is invariant under any future-preserving monotone relabelling $T_U \to f(T_U)$. The **Clock-Rate Invisibility Lemma** follows: the action knows which direction is future but not the operational rate at which universal time advances against a particular clock. Two clocks are necessary; their relative readout requires an observation map. **[lemma/open]** This lemma shapes the entire framework: every empirical statement in STF is ultimately a statement about a comparison between clocks, and every sector below — the curvature response, the flyby record, the gravitational completion, the timing prediction — is a different face of that comparison.

II.C The 2π-provenance rule

The internal phase is a compact $U(1)$ coordinate, so one primitive recurrence spans 2π in canonical radian coordinates. Every 2π in this framework must carry one of three provenance labels: conversion between angular frequency and a full recurrence; conversion between normalized integral cohomology and canonical angular representatives; or a physical law deliberately pairing a reduced correlation scale with a full cycle. The first two follow from a derived cycle or winding; the third requires an independent constitutive derivation. A mixed reduced/full pairing is not forbidden, but it cannot be presented as a causal identity. **[house rule]**

III. The Selective Transient Field

III.A The response state and the exact memory

The theory's curvature input is the positive clock-relative state

$$q_N^2 = R^2 + 8\mathcal{W}_N, \qquad \mathcal{W}_N = E_{\mu\nu}E^{\mu\nu} + B_{\mu\nu}B^{\mu\nu},$$

built from the electric and magnetic parts of the Weyl tensor relative to N^μ, together with the Ricci scalar. The response couples not to curvature directly but to its universal rate through an exact causal high-pass memory: a retarded kernel whose transfer function vanishes at zero frequency, rises through a single Drude turnover at ω_c, and saturates at unity. The turnover time is $\tau_c = 0.529$ yr; the exact kernel value at ω_c is $1/\sqrt{2}$. A statically curved universe produces no steady-state response; only change in the clock-relative curvature state is registered. **[derived]**

The readout is regulated: the compact-alignment response

$$Q_\Delta = M_*^2 \left(\sqrt{q_N^2 + \Delta^2} - \Delta \right)$$

is smooth through $q_N = 0$, linear in q_N^2 at small argument, and asymptotically linear in q_N at large argument. Its regulator Δ and scale M_* are declared parameters of the frozen architecture, carried explicitly in every downstream calculation.

III.B The timing structure and its exact provenance

The numerical timing structure of STF is the discovery record, and its dependency graph is stated exactly. Observation supplied the 3.32-year and 71-day anchors: the mean UHECR–GRB separation of the triple-coincidence events is -3.32 ± 0.89 years, and the blind likelihood over the exponent family independently returned $n = 11/8$ with mean period 3.31 years, fixing the scalar mass $m_s = h/(c^2 T) = 3.94 \times 10^{-23}\,\mathrm{eV}/c^2$. The STF emission-window closure supplied the $53.88 \simeq 54$-year outer anchor conditionally on the observed centroid and the named boundary $\tau_- = 0.1$ yr; it is a conditional closure, not an independent prediction. The Peters a^4 law [14] is the translator that maps the three times to 1466, 730, and $360\,R_S$ — successive nearhalvings of binary separation. The separations are GR images of the temporal anchors, not independently predicted radii. **[calculation/conditional convergence]**

None of these numbers is rigid. The 71-day and 1,212-day (3.32-year) structures are observational associations with legitimate data and model freedom; the approximately 54-year structure is a dependent posterior closure. A standing firewall, enforced mechanically in every release checker, bars all of them from solving any theoretical coefficient or selecting any model element. Their permitted roles are exactly two: input to a declared forward likelihood, and retrospective non-fitted validation witness. Every data confrontation in this paper respects that firewall, and each checker's zero-fit counters are part of the public record.

III.C The flyby sector: a measurement map, not a force

Pulled back to a worldline, the original STF interaction is the connection one-form $\mathcal{A} = \gamma\phi\, dq$ with curvature $\mathcal{F} = \gamma\, d\phi \wedge dq$. Its antisymmetry does no work, while a closed radio transaction can register the holonomy $\oint \mathcal{A}$. The factor of two in the Earth-flyby phenomenology is the vorticity identity $\nabla \times (\boldsymbol{\omega} \times \mathbf{r}) = 2\boldsymbol{\omega}$; the equatorial radius and declination-only dependence are the operator norm of the rotational clock channel over the closed carrier. Earth flybys are source–observer degenerate because Earth is both the rotating gravitating source and the rotating clock carrier. The constitutive clock–link normalization and each tracking configuration's utilization coefficient remain open. **[derived/theorem/open]**

This sector is the cleanest illustration of the framework's epistemic posture: an early mechanical force interpretation was withdrawn when the audit showed the interaction does no work, the withdrawal is preserved in the record, and what survives — a holonomy-level observation map with the correct factor structure — is graded exactly as far as it is proved.

III.D Carried falsifiers

The response sector carries its own falsification program independent of everything below: the 1.66-year half-cycle test of the timing structure; the 0.529/3.324-year interchange warning, which would misassign the Drude turnover and the period if the two scales were swapped; the realization-specific tensor-speed envelope of the recorded scalar–Gauss–Bonnet route, an effectively null observational prediction whose violation would falsify that recorded realization; and the rank, Ward, pole, hyperbolicity, preferred-frame, static-response, flyby-utilization, and production-map falsifiers of the frozen architecture. These remain in force at their recorded grades.

IV. The Gravitational Architecture

IV.A The supersession that started the programme

Version 8.2 superseded the claim that the local reciprocal interaction $\int \sqrt{-g}\,\phi\,D_U q_N[g,N]$ is a healthy fundamental metric action. When the curvature norm is eliminated into a finite-order local metric theory [30], its Hessian generically produces a nondegenerate metric-acceleration block and an opposite-residue quartic pole; ordinary torsion-constrained connection reduction, regular auxiliary or BF/Legendre completion, generic same-metric Plebański simplicity, spectator six-null sectors, and curvature-dependent shifted metrics do not remove that physical rank with a constant constraint structure. The supersession is preserved in the record; the surviving readout is the regulated response of §III, and the gravitational question became: what parent theory carries it consistently? Everything in this section is the audited answer, at its exact current grade.

IV.B The audit programme in brief

The answer was built adversarially, in layers, each layer frozen before the next began.

The five gates (v9.0). Open-operator and deformed-identity classification (G1); the covariant Q_Δ -environment vertex and horizon spectral supply (G2); all-loop zero-DC protection (G3); gravitational-wave emission — direct local action versus analytic parent (G4); and merger-production activation with the visible-sector vertex (G5). The audit layer attached four numeric acceptance gates to any coefficient-complete parent, to be passed simultaneously on one common branch: Hulse–Taylor orbital-decay correction below 3.59×10^{-3}; PSR J1738+0333 flux correction below 1.81×10^{-1}; a GW170817 chirp-rate envelope below 6.67×10^{-3}; and $|c_T/c - 1| \lesssim 10^{-15}$. All five gates opened; none closed at this layer.

The frozen consolidations (v9.1, v9.2). Thirteen standalone calculation records were consolidated in two frozen releases. Among their permanent results: a no-go for the common-shift Stueckelberg completion with algebraic locks, which remains controlling for that class; a one-loop static zero that is exact but non-identifiable in the full coefficient space; Derrick and material-support constraints on finite world tubes; a compactification exact-charge stop gate that closes the parameter-free route from the displayed frozen compactification; a conditional derivative-lock bridge that reopens protection through clock-origin factorization at the price of a new parent class with a genuine physical relative-rate mode; the exact bookkeeping identity $M_I = g_Q^2$, which removes an adjustable amplitude from the pulsar sector; explicit Hulse–Taylor and J1738 coefficient inequalities; and two rejected microscopic shortcuts — ordinary neutron-star tides are a safe body-dependent comparator but not the universal scalar bath, and an isolated finite tube cannot supply the gapless Drude continuum. The established rank count of the frozen architecture, $44 + 2 + 12 = 58$ per causal leg and 116 doubled, is carried as a module subtotal throughout.

The covariant architecture chain (v9.3–v9.4.2). A fifty-one-gate programme executed the covariant two-clock architecture and its constraint discipline [28,29,31]. Its permanent discipline record: four withdrawals, each by an explicit correcting gate — a premature no-parent-selected claim, a cubic window composition, a Carter-mobility identification, and a one-datum-unlock implication — together with one declared tuning (a renormalized tadpole condition, labeled a running matching datum) and two branch suspensions (the ARP-BL and CMC-BSk24 prediction branches, structural results retained). The chain also produced a microscopic material-clock normalization from the BSk24 neutron-superfluid phase cycle, and closed the exact-DHOST fork: the current parent's exact quadratic-DHOST label is retired — the regulated norm and active portal are not exact quadratic DHOST — while the order-reduced CRGC effective classification is retained and no universal DHOST no-go is claimed.

The comparative gravity lift studies (v9.5). Eleven studies took the architecture to a compact-response boundary. A finite, CMC-regular relational $P(Y)$ phase star was constructed as the frozen compact comparator; the constraint-reduced GR-plus-phase radial operator was derived and its first eight eigenvalues computed positive, with fundamental

$$\omega_0 R = 0.1889913902;$$

the physical-vacuum surface theorem showed the canonical surface traction vanishes quadratically at the free surface, so the star's information lives in a stable self-adjoint bulk spectrum rather than a boundary kernel; and the **same-port positivity theorem** was proved: any closed Hermitian same-port compact response is real, positive, and monotone below the fundamental. Study 11 then proved the decisive negative constructively: the **current-parent port non-identifiability theorem**. The parent as then written declared the scalar portal constants and the regulated norm of an eleven-component compact curvature state, but left that state symbolic; explicit families of arbitrarily small stable completions preserved every frozen datum while changing modal residues, antiresonances, constraint-block shifts, and exterior projections. No unique compact response followed from the parent data alone. The release converted the stop into an exact machine-readable completion contract and a version policy: no successor could advance by fitting timing or choosing an arbitrary projection — only by new action-level information passing the contract.

IV.C Why the negative results are load-bearing

A reader should not skim the previous subsection's negatives as throat-clearing. They are the reason the positive results below mean something. The non-identifiability theorem is what makes the subsequent completion a genuine theory choice rather than a curve-fit; the compactification stop gate is what forces new physics to enter as a declared branch rather than a silent parameter; the withdrawn claims are what calibrate the reader's trust in the claims that stand. The framework's rule — nothing deleted, everything graded — is not bookkeeping; it is the theory's principal defense against its own authors.

V. The Compact Completion

V.A What the contract demanded and what the amendment supplied

The Compact CRGC Port Completion Amendment is the record that answered Study 11's contract, and it is the programme's one new theory choice since the freeze. It replaces the symbolic compact map by an explicit eleven-component, sign- and coefficient-complete order-reduced map; evaluates it on the frozen phase star; supplies first and second variational kernels; derives — rather than deletes — the mixed constraint block, which materially matters: the naive unity portal coupling fails its own stability test once the derived block is included, two of five carrier kinetic eigenvalues turning negative. The derived radial stability window is

$$|g_R| < 0.4312478776,$$

and the amendment freezes the dyadic value $g_R = 1/4$ inside it, chosen with zero timing input. The five effective kinetic eigenvalues at the frozen choice are $(0.664, 0.914, 0.967, 0.990, 0.998)$. A canonically normalized outgoing relative-clock carrier, matching condition, detector functional, energy ledger, and an explicit reference-absence declaration complete the contract's sections; all seven pass.

V.B Scope, honestly

The amendment's self-grade is exact and this paper carries it verbatim: a **radial-classical completion pass** — not a full nonlinear, nonradial, or quantum completion. On that scope, and only on it, the long-paused compact-port gate is closed by the selected amendment. The gates G1 through G5 remain open, four of them materially advanced: the radial constraint audit does not inherit globally; the same-parent microscopic environment is not completed; quantum counterterm protection is open; and the normalized common-branch emission and detector map were, at this layer, still missing. The source-and-transport programme of the next section then advanced those gates with a selected source and transport map; it did not close them — every gate G1 through G5 remains formally open. What the amendment changed is categorical nonetheless: a normalized retarded compact-to-detector response functional exists on one explicit two-clock branch, so the question "what does STF predict?" stopped being ill-posed and became a calculation with named missing inputs.

VI. Source and Transport

VI.A From binary tide to source clock

With a normalized compact port in hand, the source question became concrete: what drives the compact response of a merging binary, and when? The chain runs in four derived steps.

The leading quadrupolar tide has zero linear overlap with the radial port; the first nonzero source is quadratic, giving a port drive $S_{\mathrm{port}} \propto b^{-6}$ in binary separation b and a detector-side response rate $\mathcal{D}Z \propto b^{-14}$. Through the Peters relation [14] $b \propto \tau^{1/4}$ — the same GR translator the timing structure has always used — this is $\mathcal{D}Z \propto \tau^{-7/2}$ in time before merger. **[derived]**

The source's particle side is an independent capacity statement, separate from the response-rate chain above. A Hillas-type magnetospheric capacity with the declared magnetar-strength comparator field and the programme's inherited chirp-mass band gives a maximum rigidity that grows as the binary tightens, $\mathcal{R}_{\max} \propto \tau^{-5/8}$; inverting it yields the frozen source-clock law

$$\boxed{\tau_{\mathrm{onset}}(\mathcal{R}) = C\,\mathcal{R}^{-8/5}:}$$

particles of rigidity $\mathcal{R}$ can first be produced at time τ_{onset} before merger. The exponent is derived; the coefficient C is a normalization with physical content, and its story is the next subsection. The declared local capacity surfaces put the 1 EV tier at 619.63–1493.75 days and the 5 EV tier at 47.18–113.74 days before merger — bands that contain the observed 1,212-day and 71-day structures respectively. This containment is retrospective consistency, recorded with its selection status declared: the comparator inputs were chosen by sessions that knew the target numbers, though no equation used either observed value. **[retrospective consistency, not blind]**

VI.B The two normalization branches

The local calculation then failed its own production audit: local magnetospheric UHE ion production fails the curvature ceiling below 1 EV, and representative charged transport does not preserve a premerger detector lead. The surviving production route is a remote converter — a Poynting-flux bubble at distance from the compact object, where merger outflow converts magnetic luminosity to UHE ions [22–24]. A parameter sweep established the branch as a conditional existence result, not a unique selection. The normalization consequence is exact: the remote branch multiplies the local rigidity capacity by a factor

$$\mathcal{F} = \frac{\zeta_{\mathrm{acc}}\,\min(\beta_w/\eta_{\mathrm{acc}},\,\epsilon_c)}{\sqrt{2 f_\Omega \beta_w}},$$

built from five measurable bubble parameters — geometry fraction, outflow speed, coherence ratio, and two acceleration efficiencies — and therefore multiplies the timing coefficient by $\mathcal{F}^{8/5}$:

$$C_{\rm rem} = C_{\rm loc}\,\mathcal{F}^{8/5}, \qquad C_{\rm rem} = C_{\rm loc} \text{ iff } \mathcal{F} = 1.$$

At the frozen reference point the factor is exactly $\mathcal{F} = \sqrt{5}$, lifting the 1 EV band to 2245.47–5413.20 days. The reference point is a declared tuple, not a measurement; the dossier work of §VIII found no literature-supported joint prior for the five parameters, and plausible literature-leaning values move $\mathcal{F}$ substantially in both directions. $\mathcal{F}$ is, at this writing, the single most consequential unmeasured number in the programme.

VI.C Transport, in SI and honestly

Charged transport contributes a nonnegative small-angle delay $\Delta_{\rm mag} = A\,\mathcal{R}^{-2}$, and A does not need to come from the STF Lagrangian at all: it is external propagation physics, legitimately fixed from independent measurements [25–27]. The closure derives it in two closed-form pieces — an extragalactic coefficient $A_{\rm EG} = 5.1135 \times 10^7\,(D_{\rm Mpc}\,\beta_{\rm EGMF})^2$ days with $\beta_{\rm EGMF}$ the field-and-coherence combination in nanogauss–megaparsec units, and a Galactic coefficient $A_{\rm G}$ from the turbulent line-of-sight integral. The honest arithmetic is sobering and is stated as such: the reference Galactic line of sight alone gives $A \approx 3.19 \times 10^5$ days — a delay near 874 years at 1 EV and still 798 days at 20 EV — which erases any premerger lead. A detected premerger charged lead therefore requires an exceptionally clean magnetic corridor, a high rigidity, or both; quantitatively, the lead survives at 20 EV only for line-of-sight coefficients some forty times below the Galactic reference. The neutral channel has no such delay, which is why the GRB association is the clean one. The framework does not soften this: the transport ledger records that a representative line of sight fails, that standard neutral conversion candidates fail, and that the surviving corridor is narrow and must be established per event. **[derived; conditional-fail-open]**

VII. The Prediction Freeze

VII.A The affine theorem

The detector lead $L(\mathcal{R}) = C\mathcal{R}^{-8/5} - A\mathcal{R}^{-2}$ looks nonlinear, but it has an exact affine representation:

$$X = \mathcal{R}^{2/5}, \qquad Y = \mathcal{R}^2 L, \qquad \boxed{Y = CX - A.}$$

The consequence is the framework's first coefficient-eliminating falsifier. Two rigidity-resolved events from one source, one emission episode, and one line of sight determine C and A exactly; every third event is then a prediction with no refit permitted. Physicality requires positive slope and nonpositive intercept, which for two positive-lead events is equivalent to the parameter-free pair inequality

$$\frac{L_2}{L_1} \geq \left(\frac{\mathcal{R}_2}{\mathcal{R}_1}\right)^{-8/5}, \qquad \mathcal{R}_2 > \mathcal{R}_1.$$

Forcing the known 71-day and 1,212-day structures into this machinery as one common multiplet yields a negative inferred magnetic-delay coefficient, $A \approx -589$ days — equivalently an inadmissible positive affine intercept — and fails the physicality inequality — which is the calculation's own way of saying what the record already declares: the two known structures belong to different association populations and are not a same-source rigidity pair. They are validation witnesses, not calibration data. **[theorem; negative control]**

VII.B The preregistered protocol

The test is frozen before any qualifying data exists. The eligibility contract demands one source, one emission episode, one line of sight, at least three events with distinct informative rigidities, independent energy-or-composition likelihoods, documented uncertainties and selection function, and no use of the sample in constructing the source model. The calibration split is immutable: events ordered by dataset identifier, first two eligible calibrate, all later events are held out, and the order may not change after residual inspection. Rejection thresholds are fixed — single-event significance at $z = 5$, a one-percent global tail, a ninety-nine-percent source-slope confidence — and the forbidden-refit list bars the source exponent, the transport exponent, the frozen normalization band, calibration-pair or membership changes after residual inspection, magnetic models selected by timing residuals, and any use of the legacy anchors as calibration. An executable evaluator with a worked synthetic example ships with the record, so the test can be run by anyone, on the day a qualifying multiplet exists, without contacting the authors.

VII.C The measured-input path

The normalization closure upgrades the target from relative to absolute. Because C is now a formula in source observables and $\mathcal{F}$, and A a formula in line-of-sight magnetics, a source with an independently measured dossier — mass and field likelihoods, bubble parameters, composition likelihood, propagation inputs, all frozen before any timing residual is seen — yields a predicted lead band for every rigidity with no timing calibration at all. The programme's stated maximum, short of data: *independently measured source and propagation properties determine C and A, so every event is predicted.* The two execution modes are distinct, and both are frozen: the preregistered relative test, in which the first two eligible events calibrate C and A as nuisance coefficients; and the absolute measured-input route, in which no event timing calibrates anything. What remains between the current state and the absolute maximum is measurement — principally $\mathcal{F}$ — and one qualifying sample. Both are outside the Lagrangian, and neither can be shortcut from inside it; the version policy forbids exactly that shortcut.

VII.D What the anchors mean under the freeze

Under the frozen law each branch assigns rigidities to the known structures. For the 1,212-day structure: 0.66–1.14 EV on the local branch, 1.47–2.55 EV on the remote branch — the two differing by exactly $\mathcal{F} = \sqrt{5}$. The 71-day structure, being a neutral-channel association, receives no particle-charge assignment; its remote reading, 8.66–15.01 EV firing by $T - 71$ days, is a statement about the source's accelerator tier. These assignments are not fits — the anchors retain their observational freedom — but they are exposed: they are exactly what the composition data of the next section can check.

VIII. The Composition Discrimination

VIII.A The population, pinned

The observational programme's event set is now a fully specified object: the Pierre Auger Observatory Open Data release [15] (the public high-level sample), files hash-recorded, cut $E > 20$ EeV and zenith $< 80^\circ$ over 2004–2018, yielding 498 rows and, after four documented duplicate identifiers, **494 unique events** — reproduced independently on the review side from the raw files. Median energy 26.8 EeV; five percent of the sample above 57 EeV; maximum 144 EeV. Of these, 408 lie in the $10^{19.3}$–$10^{19.6}$ eV band where the published composition analysis provides mass-group fractions. Coverage of the 86 above the band is completed by constraining 69 and bounding 17: the 69 fall in the final published fraction point (19.6–19.8, nitrogen-dominated) and are close to maximally discriminating — their local charge windows are entirely above iron — while the 17 others (twelve with published moments but no fraction table, five beyond the companion paper's stated 100 EeV range [18]) are carried as honest $[0, 1]$ probability bounds rather than fitted fractions. The completion strengthens the central remote preference (completed-population central envelopes: at most four percent local against seven to twenty-four percent remote) and leaves the recorded verdict unchanged.

VIII.B The confrontation

Rigidity is charge-normalized energy, $\mathcal{R} = E/Z$. Each branch's rigidity band for the 1,212-day structure therefore maps, at each event's energy, to a nuclear-charge window $Z = E/\mathcal{R}$ — and the two branches predict different nuclear physics. Propagated event by event: the local branch demands charges predominantly **above iron** — for 185 of the 494 events no physical nucleus lies in the local window at all — while the remote branch at the reference lift implies the intermediate range $Z \approx 8$–14, the oxygen-through-silicon group, across the bulk of the population.

The measured side is the Pierre Auger Collaboration's four-group mass-fraction analysis [19] (hydrogen, helium, nitrogen, iron; EPOS-LHC and Sibyll 2.3d; the collaboration's own preliminary label carried), in which the in-band iron fraction is small — rising, model-dependently, to five to twelve percent at the 19.6–19.8 point; the published surface-detector deep-learning $X_{\max}$ moments [17,18] independently corroborate the intermediate, narrowing trend but supply no fraction table. Confronting likelihood with windows, with per-event energy errors, the fourteen-percent common energy-scale systematic [20], and hadronic-model spread all propagated: the population-mean consistency for the 408 in-band events is **at most a fraction of a percent for the local branch against eight to twenty-three percent for the remote branch** at central estimates; intentionally conservative envelopes on the published error bars overlap, so no branch is excluded. The recorded verdict is

> **remote favored, with no branch exclusion,**

and it is conditional on a declared within-group interpolation: the literal four-charge template calculation is retained in the record and leans the other way — a granularity dependence, with the remote window falling between the nitrogen and iron template points — disclosed and retained rather than resolved by fiat. A seven-event hybrid-$X_{\max}$ cross-check [21] is model-dependent and non-discriminating. **[retrospective non-fitted branch discrimination]**

VIII.C Three arrows, one population

The result's weight comes from convergence, not from any single number. The framework's own energy-stratified timing tests (Test Authority [12], Test 31b) — run on the discovery side, before any branch existed — found the STF timing signal carried by the sub-75 EeV population and diluted above it. Auger's measured composition says that population is light-to-intermediate. And the remote branch — derived from capacity physics and bubble geometry with no timing and no composition input — independently demands the same intermediate charge range for the 1,212-day carriers. Three separately obtained consistency relations select one population; the composition side is a population-level measurement, and no joint likelihood is claimed. A fourth, quieter consistency: the discovery-side inference that timing scatter scales as Z^2 at fixed energy (Test Authority [12], Test 42) is exactly the charge dependence of the frozen $\mathcal{R}^{-2}$ transport law. One supersession follows for the Test Authority document's older wording: its energy-based proxy "proton-dominated" for the signal-carrying 20–50 EeV events should read "light-to-intermediate," which strengthens, not weakens, the consistency; the superseded wording remains in the record.

VIII.D The exposed surface

The convergence is conditional, and the condition is now a single number. The composition consistency holds at the reference $\mathcal{F} = \sqrt{5}$; near $\mathcal{F} = 1$ the remote window merges into the local, super-iron region and the consistency collapses; the closest simulation-leaning parameter values scatter $\mathcal{F}$ roughly between 0.6 and 1.4, while the dossier finds no defensible joint prior. The composition data therefore function as an independent retrospective handle on $\mathcal{F}$: a future determination near the reference locks timing, composition, and production viability together, while at $\mathcal{F} = 1$ the remote window merges into the disfavored local one. The exposure is now quantified on a declared grid against the frozen $\mathcal{F} = 1$ comparator: robust consistency for $\mathcal{F} \in [1.55,\ 28.70]$, robust falsification below 0.70 or above 67, indeterminate between — with the frozen reference $\sqrt{5}$ inside the consistent band and the simulation-leaning excursions straddling the broken and indeterminate zones. The surface is labeled retrospective and may not set $\mathcal{F}$; the number itself must come from source observation or an expanding-flow simulation ensemble meeting the published precision specification (ten percent on the timing coefficient requires about six percent on $\ln \mathcal{F}$, with covariance). The preregistered multiplet test is a separate instrument: its calibration step measures the coefficient C empirically, which would cross-check an independently determined $\mathcal{F}$ rather than substitute for it. This is the paper's most exposed claim surface, deliberately.

IX. Falsification Program and Status

IX.A The standing falsifiers

The programme can now be wrong in more ways than at any earlier version, which is its principal achievement. In force, at their recorded grades: the 1.66-year half-cycle timing test and the 0.529/3.324-year interchange warning of the response sector; the rank, Ward, pole, hyperbolicity, preferred-frame, static-response, flyby-utilization, and production-map falsifiers of the frozen architecture; the four numeric gravitational acceptance gates of §IV; and the new response-law rejections — non-collinearity of an eligible multiplet in the affine plane at the declared thresholds, a nonpositive inferred C, a significantly negative inferred A on a common charged branch, exclusion of the $-8/5$ source slope in independently reconstructed source time, failure of every normalization in the frozen band, a transport exponent incompatible with -2 on the selected branch, and a premerger charged lead on a line of sight whose measured transport coefficient forbids it. To these the composition axis adds its own: an independently determined $\mathcal{F}$ in the robust-falsification zones (below 0.70 within the audited grid), or a measured heavy composition for the signal-carrying population, would each break the retrospective structure.

IX.B What is established and what is not

Established, with machine-checked records: the two-clock theorem and its kinematics; the exact causal memory and regulated readout; the timing structure's provenance discipline; the audited supersession of the naive gravitational action; the phase-star baseline spectrum and the same-port positivity theorem; the port non-identifiability theorem and the radial-classical completion that answers it; the frozen source and transport exponents; the affine response theorem and its preregistered test; the measurable-input normalization closure; and the retrospective composition discrimination at its declared grade.

Not established, stated as plainly: any gate closure beyond the radial-classical compact port; full nonradial constraint closure, quantum completion, or a two-polarization claim; a universal absolute event time — the coefficients await the measured dossier, principally $\mathcal{F}$; a unique remote-converter geometry; per-event nuclear charge for any observed event; a blind validation of any kind — every data confrontation to date is retrospective, and the known anchors preceded every comparator; and published four-group fractions above $10^{19.8}$ eV — seventeen events remain honestly bounded rather than constrained. The zero-fit record is unbroken: no timing anchor has ever solved a theoretical coefficient, a property asserted mechanically by every checker in the chain.

IX.C Status

$$\boxed{\text{Coherent gravitational candidate — not a completed gravity theory.}}$$

Programme status: **prediction-ready and conditionally falsifiable.** The response law's remaining freedom is measurement, not algebra — the gravitational completion retains its separate open obligations listed above; the programme's next decisive inputs are an independently determined $\mathcal{F}$ and one qualifying held-out multiplet; and it has bound itself, by frozen protocol and version policy, to be judged by them.

X. Provenance and the Verification Record

X.A Version history

VERSION	DATE	CONTENT	RECORD IDENTITY (SHA-256, ABBREVIATED)
V7.9	2026	legacy derivation record; downstream-sector delegate	published edition
V8.1	26 Aug 2026	frozen baseline; two-clock theorem; corrected provenance	`4788576a`
V8.2	28 Aug 2026	gravitational supersession and revision (repaired release)	`2cd54dae`
V9.0	28 Aug 2026	five-gate audit layer	`2ef09ed7`
V9.1	29 Aug 2026	frozen consolidation, seven records; research boundary	`3bbea34b` / author `177fd72b`
V9.2	30 Aug 2026	six-record consolidation; derivative-lock programme	`842863ac` / author `100bfe00`

VERSION	DATE	CONTENT	RECORD IDENTITY (SHA-256, ABBREVIATED)
V9.2-UC-R1	30 Aug 2026	matter-blind activation; M5 discharge	`04c37aaa`
V9.3	30 Aug 2026	relative-rate and quantum world-tube decision	embedded in chain
V9.4–V9.4.2	31 Aug 2026	fifty-one-gate covariant architecture; DHOST fork closure	package `b7e10376`
V9.5	1 Sep 2026	comparative gravity lift studies; non-identifiability; contract	package `49921c5e`
V9.6	1 Sep 2026	prediction freeze; affine theorem; preregistration	package `c301a801`
V9.6.1	1 Sep 2026	measurable-input normalization closure	package `e322752d`
Study 19	1 Sep 2026	composition discrimination; dossier part 1	package `243fc7c8`
Study 20	1 Sep 2026	high-energy completion; F-measurement specification	package `13744e3e`

Each release embeds or hash-pins its predecessor byte-intact; the chain from the frozen v8-series baseline to this edition is continuous and independently re-verified. Superseded statements remain readable inside the frozen payloads under explicit notices.

X.B The Verification Record

The complete technical stack — every release manuscript with its historical layers, every calculation record, every checker, every negative result, every withdrawal — is preserved as the *STF First Principles Verification Record* [13], published alongside this paper. Auditing it requires Python with NumPy and nothing else: each package verifies its own checksums, reruns its assertions — over thirty-three million across the frozen chain, with the zero-fit and zero-timing-anchor counters asserted in every release — and regenerates its results byte-identically; the release archives are deterministic builds, and the v9.5 and v9.6 archives were independently rebuilt byte-for-byte on review. The record, not this paper, is the framework's proof; this paper is its face.

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The calculations, audits, and adversarial reviews consolidated here were carried out with AI research assistants operating under the programme's verification discipline, with every quantitative claim bound to machine-checked records. Errors of judgment remain the author's.

Conflict of Interest

The author declares no conflict of interest.

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Project papers (existshappens.com):

1. Z. Paz, *The Selective Transient Field from First Principles*, V7.9 — delegated derivation record for downstream sectors.
2. Z. Paz, *Theory of Time*, V4.3.
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4. Z. Paz, *Framework Guide*, V3.3.
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11. Z. Paz, *uhecrtoday.com/papers/manuscript/">Observational Manuscript*, V3.20, uhecrtoday.com/papers/manuscript/ — the discovery record: the UHECR–GW–GRB statistical case, the 3.32-year and 71-day anchors, and their significances.
12. Z. Paz, *uhecrtoday.com/papers/test-authority/">STF Test Authority Document: Comprehensive Validation Framework*, V1.5, uhecrtoday.com/papers/test-authority/ — defines the tested population (Pierre Auger public data 2004–2018, E > 20 EeV, zenith < 80°, N = 494) and the energy-stratified timing and dipole-anisotropy tests cited in §VIII.C; its energy-based composition proxy is superseded as noted there.

The Verification Record:

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External sources (as used in the frozen records):

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End of STF First Principles, Version 9.6.1 — Backbone Edition.

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