History-Dependent Dynamics from Persistent Commitment Memory: A Kernel Formulation of VERSF

VERSF Theoretical Physics Programme
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For the General Reader

Standard physics assumes that the present state of any system contains everything needed to determine its future. History matters only insofar as it produced the current state — once that state is fixed, the past is, in effect, forgotten.

This paper argues that assumption is not quite right.

Within the VERSF framework, physical events are irreversible: once something happens, it cannot unhappen. This irreversibility turns out to have a subtle but permanent consequence. The equations governing how physical fields evolve show that every past event leaves a faint trace — a residue that never fully vanishes — in the field that governs where and when future events can occur. The present is not shaped by the current state alone. It is shaped by the current state *plus* the entire accumulated history of what has come before, with older events contributing less but never contributing nothing.

The effect is small. In everyday physics it is entirely negligible, which is why standard Markovian physics works so well. But near critical thresholds, in quantum systems, or in extreme gravitational environments, the accumulated memory of past events can become significant enough to change outcomes in measurable ways.

The central prediction is concrete: physical systems governed by this framework should exhibit relaxation behaviour with a characteristic long tail — decaying more slowly than standard exponential relaxation — arising precisely because the field in which they are embedded carries the memory of all prior events.

The picture this suggests is of reality as something closer to a lake than a blank slate. Each event creates ripples that fade but never disappear. New events do not happen in a neutral, empty space — they happen in a field already carrying the faint, structured residue of everything that preceded them.

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Abstract

Within the Void Energy-Regulated Space Framework (VERSF), physical reality is constituted by irreversible commitment events that source perturbations in the commitment-capacity field κ. In the companion paper *Fact-Momentum* [FM], these perturbations were shown to propagate via a retarded Green's function whose interior tail decays algebraically as τ^{-1} — a structural consequence of the massive scalar propagator in 3 spatial dimensions with emergent time (d_s = 3). That result established the persistence of causal influence but left open its dynamical interpretation.

This paper provides that interpretation. We argue that, because VERSF sources are irreversible — commitment events cannot be uncommitted — the standard retarded propagator acquires a distinct physical status not present in conventional field theories: its causal convolution over the source history constitutes a **memory** of prior fact-formation events, one that actively conditions all future dynamics at that point. We define the **fact-memory kernel $\mathcal{M}$** as the retarded response function of the κ-field, construct the **accumulated memory field** Ξ(x,t) as its convolution against the committed-event density, and derive a class of **history-dependent evolution equations** in which Ξ enters explicitly as a dynamical variable alongside the instantaneous state.

The central structural result is that physical relaxation processes governed by VERSF acquire a non-exponential, algebraically decaying tail $\sim t^{-1}$ over an extended intermediate regime for spatially distributed committed-event sources, transitioning to $\tau^{-3/2}$ asymptotically for point sources. We derive this for an explicit model observable — the decay of a κ-field fluctuation in the presence of a steady committed-event background — and contrast it with the purely exponential relaxation of a standard Markovian field theory. The correction is small in low-density regimes but is parametrically enhanced near commitment-density thresholds and in extreme gravitational environments.

All explicit kernel expressions are conditional on the companion result that the effective spatial dimension of the VERSF transport sector is $d_s = 3$.

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1. Introduction

Every established framework for dynamical physics assumes, at some level, that the present state of a system contains all information necessary to determine its future evolution. This is the **Markovian assumption**. In quantum mechanics, it is enforced by unitarity and the completeness of the wavefunction. In classical field theory, it is enforced by specifying initial data on a Cauchy surface.

The Markovian assumption is structurally convenient and empirically well-supported in most regimes. It is not, however, derived from first principles. It is a choice.

Within the VERSF programme, this choice becomes questionable for the following reason. The fundamental ontological events of the framework — **commitment events**, the irreversible formation of facts — are by definition not undoable. Once a fact is committed, it remains committed. Its influence on the κ-field propagates forward in time via the retarded Green's function, and — as established in [FM] — this propagation does not terminate. The interior tail of the massive scalar propagator ensures that the influence of a commitment event at (x′, t′) persists throughout the entire future causal cone of that event, decaying as τ^{-1} but never reaching zero.

This has a direct consequence that distinguishes VERSF from standard field theories:

In a standard field theory, the retarded propagator computes a field value from its sources, but the sources themselves may increase, decrease, or reverse. In VERSF, the sources — commitment events — are irreversible. A committed fact cannot be de-committed. The committed-event density $\rho_{committed}$ is therefore non-decreasing at each spatial location: the source term in the convolution only ever grows. The accumulated memory field Ξ is not itself monotone, because the oscillatory kernel produces partial cancellation between contributions from different epochs; but the integrated causal weight of prior events only ever accumulates, and is never reset.

This irreversibility is what makes the memory interpretation non-trivial and specifically VERSF-motivated. It is not merely a restatement of retarded propagation. It is a claim that the causal history of fact-formation constitutes an active physical memory — one that modifies present dynamics — rather than an initial condition that the present state supersedes.

The remainder of this paper develops this claim precisely.

Section 2 establishes the necessary background from [FM].
Section 3 defines the fact-memory kernel and the accumulated memory field Ξ, and argues for their interpretation as genuinely dynamical variables.
Section 4 derives the modified evolution equation in which Ξ enters explicitly.
Section 5 computes the asymptotic structure of the kernel and derives the τ^{-1} decay law.
Section 6 presents an explicit model calculation demonstrating the non-Markovian correction to κ-field relaxation.
Section 7 discusses physical regimes in which memory effects are enhanced.
Section 8 states open problems.
Section 9 concludes.

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2. Background: Propagation and the Interior Tail

We briefly recall the relevant results from [FM]. The κ-field satisfies the sourced equation:

$$(\Box + m^2)\, \kappa(x,t) = \rho\_committed(x,t) \quad (2.1)$$

where □ is the d'Alembertian in the Level 4 emergent description — operating across 3 spatial dimensions with emergent time, not a fundamental four-dimensional spacetime — m is an effective mass parameter whose microscopic origin lies in fold-interface dynamics (see [FM] §7 and open problem §8.1 below), and ρ_committed(x,t) is the committed-event density — a non-negative, non-decreasing function of time at each spatial location.

The retarded solution is:

$$\delta\kappa(x,t) = \int d^3x' \int_{-\infty}^{t} dt'\, G\_ret(x-x', t-t')\, \rho\_committed(x',t') \quad (2.2)$$

With d_s = 3 spatial dimensions and emergent time at Level 4, the massive retarded Green's function is:

$$G\_ret(r,\tau) = \theta(\tau) \left[\delta(\tau-r)/(4\pi r) - \theta(\tau-r) \cdot m\, J_1(m\sqrt{(\tau^2-r^2)}) / (4\pi\sqrt{(\tau^2-r^2)}) \right] \quad (2.3)$$

where $r = |x - x'|$, $\tau = t - t'$, and J_1 is the Bessel function of the first kind. At late times $\tau \gg r, m^{-1}$:

$$G\_ret \sim \cos(m\tau + \varphi) \cdot m / (4\pi\tau \cdot \sqrt{(2\pi m\tau)}) \quad (\tau \to \infty) \quad (2.4)$$

The leading envelope decays as $\tau^{-3/2}$ asymptotically, with the less-suppressed τ^{-1} behaviour persisting over intermediate time scales $m^{-1} \ll \tau \ll m^{-1}(mr)^2$. It is this intermediate-time regime that generates the observable effects computed in Section 6.

The key property, established in [FM], is that G_ret is **nowhere vanishing** in the interior of the causal cone. This is a structural fact specific to d_s = 3; for d_s = 1 or d_s = 2 the propagator has different asymptotic behaviour and the interior tail takes a different form. All kernel expressions throughout this paper operate entirely within Level 4 emergent spacetime; the causal structure, propagation speed, and oscillatory structure of G_ret are emergent features of that description and are well-defined precisely because time has already emerged at this level. No expression in this paper is intended to describe, or presupposes, dynamics below Level 4.

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3. The Fact-Memory Kernel and the Memory Field Ξ

3.1 Definition

We define the **fact-memory kernel** as:

$\mathcal{M}(x,t; x',t') \equiv G\_ret(x-x', t-t') \cdot \theta(t-t')$ (3.1)

The θ-function is already contained in G_ret; we make it explicit to emphasise that $\mathcal{M}$ has support only on the future causal cone of (x′,t′).

Remark on novelty. In an arbitrary field theory, this identification would be tautological: the retarded propagator simply is the causal Green's function. What makes it non-trivial in VERSF is the character of the source. Because ρ_committed is irreversible — it is a density of events that, once occurred, cannot be undone — the causal convolution against $\mathcal{M}$ is not merely a computational device for evolving the field. It is a **running weighted integral over the entire history of fact-formation**, one that cannot be reset by any subsequent physical process. In a standard field theory, a source that was switched on and then off would, after sufficient time, leave no residue in the field (to within the decay rate of the propagator). In VERSF, the source never switches off: ρ_committed is non-decreasing at each spatial location, so the source term in the convolution only ever grows. The field Ξ is not itself monotone — the oscillatory kernel produces partial cancellation between contributions from different epochs — but the integrated causal weight of prior events only ever accumulates.

3.2 The Accumulated Memory Field

Define the **accumulated memory field**:

$\Xi(x,t) \equiv \int d^3x' \int_{-\infty}^{t} dt' \, \mathcal{M}(x,t; x',t') \, \rho\_committed(x',t')$ (3.2)

so that equation (2.2) becomes simply δκ(x,t) = Ξ(x,t).

We identify Ξ as a **genuine dynamical variable**, not merely a derived quantity. The argument is that the map from commitment history to instantaneous field value is many-to-one: two distinct histories can produce the same $\kappa(x,t_0)$ at some time t_0 while yielding different values of $\Xi(x,t_0)$, and those differences propagate into distinct futures.

A minimal construction makes this concrete. Work in 0+1 dimensions (a single spatial point) and consider two committed-event histories from $t = 0$ to $t = t_0$:

- **History A**: $\rho_A(t') = \rho_0$, constant throughout $[0, t_0]$
- **History B**: $\rho_B(t') = 0$ for $t' < t_0/2$, then $\rho_B(t') = 2\rho_0$ for $t' \geq t_0/2$

Both histories have the same total committed-event count $\rho_0 t_0$ and can be tuned to produce the same instantaneous value $\kappa(t_0)$. But their accumulated memory fields differ:

$$\Xi_A(t_0) = \int_0^{t_0} \mathcal{M}(t_0-t')\, \rho_0 \, dt'$$

$$\Xi_B(t_0) = \int_{t_0/2}^{t_0} \mathcal{M}(t_0-t') \cdot 2\rho_0 \, dt'$$

Since $\mathcal{M}$ is not constant over $[0, t_0]$, these integrals are not equal in general: History A weights early-time kernel values that History B does not. $\Xi_A(t_0) \neq \Xi_B(t_0)$ despite identical $\kappa(t_0)$ and identical present source rate. Their future evolutions therefore differ through the history term $\mathcal{K}$ in equation (4.2).

Ξ therefore carries **independent causal information** not encoded in the instantaneous state. This is the precise sense in which VERSF dynamics are non-Markovian.

3.3 Evolution of Ξ

Ξ satisfies a closed integro-differential equation. Differentiating (3.2):

$$\partial_t\Xi(x,t) = \int d^3x' \int_{-\infty}^{t} dt' \, \partial_t\mathcal{M}(x,t; x',t')\, \rho_{committed}(x',t') + \rho_{committed}(x,t) \quad (3.3)$$

The boundary term at $t' = t$ contributes $\rho_{committed}(x,t)$ via the $\delta(\tau-r)|_{r=0}$ component of G_{ret}. The integral term encodes the memory of prior events propagating forward. This structure — an evolution equation with an explicit history integral — is characteristic of Volterra integro-differential equations, and the theory of such equations (existence, uniqueness, asymptotic behaviour) applies directly to Ξ under suitable regularity conditions on $\rho_{committed}$.

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4. History-Dependent Evolution

Let $O(t)$ denote any observable that depends on the local κ-field and its derivatives. In a Markovian theory, the evolution equation takes the form:

$$\dot{O}(t) = F[O(t), \kappa(x,t), \rho_{committed}(x,t)] \quad (4.1)$$

In the VERSF memory-kernel formulation, this generalises to:

$\dot{O}(t) = F[O(t), \kappa(x,t), \rho\_committed(x,t)] + \mathcal{K}O; \boldsymbol{\mathcal{M}}, \rho\_committed$ (4.2)

where the memory correction functional is:

$\mathcal{K}O; \boldsymbol{\mathcal{M}}, \rho \equiv (\delta F/\delta\kappa)|\_\{\kappa_0\} \cdot \int d^3x' \int_0^t dt' \boldsymbol{\mathcal{M}}(x,t; x',t') \rho\_committed(x',t')$ (4.3)

Here $\delta F/\delta\kappa$ is the functional derivative of the evolution law with respect to the κ-field, evaluated at the background κ_0, and the lower limit $t' = 0$ marks the onset of the committed-event history (a choice of reference epoch; the sensitivity of the result to this choice is suppressed by the algebraic decay of $\boldsymbol{\mathcal{M}}$ over the interval $[-\infty, 0]$ and is parametrically small for $mt \gg 1$, though not exponentially so given the power-law kernel).

Equation (4.2) is the **VERSF history-dependent evolution equation**. Its structure is that of a Nakajima–Zwanzig equation from the theory of open quantum systems — a form well-known to arise whenever relevant degrees of freedom are coupled to an environment whose state is not instantaneously reset. In VERSF, the role of the environment is played by the full commitment history; the memory kernel $\boldsymbol{\mathcal{M}}$ plays the role of the bath correlation function.

The Markovian limit is recovered when $\boldsymbol{\mathcal{M}}$ decays sufficiently rapidly that the integral in (4.3) is dominated by $t' \approx t$. The Markovian limit corresponds formally to kernels with finite memory time; the VERSF kernel violates this condition by possessing algebraic decay with no finite cutoff. In standard field theories the Markovian approximation is appropriate: the source can reverse, so only recent history is causally relevant. In VERSF, the irreversibility of the source prevents this truncation, and the full history integral is required in principle, even if contributions from the distant past are suppressed by the algebraic decay of $\boldsymbol{\mathcal{M}}$.

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5. Intermediate and Asymptotic Structure of the Memory Kernel

For an observation point at $x = 0$ and a committed event at distance $r = 0$, the on-source kernel reduces to:

$\boldsymbol{\mathcal{M}}(0,\tau; 0,0) = G\_ret(0,\tau) = \delta(\tau)/(4\pi) - m^2 J_1(m\tau)/(4\pi m\tau) \cdot \theta(\tau)$ (5.1)

At intermediate times $m^{-1} \ll \tau$, using the asymptotic expansion $J_1(z) \sim \sqrt{(2/\pi z)} \cos(z - 3\pi/4)$:

$\boldsymbol{\mathcal{M}}\_late(\tau) \approx -(m^{(3/2)} / 4\pi) \cdot \sqrt{(2/\pi)} \cdot \cos(m\tau - 3\pi/4) / \tau^{(3/2)}$ (5.2)

The envelope decays as $\tau^{-3/2}$. The cumulative memory contribution from the point-source kernel up to time T is:

$\int_0^T \mathcal{M}\_late(\tau)\, d\tau \sim T^{(-1/2)}$ (5.3)

This integral is convergent — the oscillating $\tau^{-3/2}$ kernel is absolutely integrable — but the convergence is slow, with the partial sum growing as $T^{(1/2)}$ before oscillatory cancellation sets in. The cumulative influence therefore remains non-negligible over extended time scales even for the point-source kernel. For a spatially extended source with non-zero support at $r > 0$, the effective on-axis kernel integrated over the source volume acquires an additional factor that softens the decay to an effective τ^{-1} power law over the intermediate regime, consistent with the result quoted in [FM]. The full derivation of this spatial-integration step — including the dependence on source geometry and the location of the crossover scale τ_cross — is deferred to a companion paper and registered as open problem §8.6:

$\mathcal{M}\_eff(\tau) \sim \cos(m\tau + \varphi) / (m\tau)$ for $m^{-1} \ll \tau \ll \tau\_cross$ (5.4)

where τ_cross is a crossover scale set by the spatial extent of the source distribution.

The central point: over the physically relevant intermediate regime, the memory kernel decays as a power law, not exponentially. The τ^{-1} scaling refers to this intermediate regime for spatially extended sources; the strict asymptotic decay remains $\tau^{-3/2}$ for point sources. Systems governed by exponentially decaying kernels are effectively Markovian after a few memory time scales. Systems governed by power-law kernels accumulate a memory contribution that remains non-negligible over extended time scales, even though it is convergent.

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6. Non-Markovian Correction to κ-Field Relaxation

To demonstrate a concrete physical consequence, we compute the non-Markovian correction to the relaxation of a κ-field fluctuation.

6.1 Setup

Consider a spatially homogeneous perturbation $\delta\kappa(t)$ about a background with constant committed-event rate ρ_0 (a rate in emergent physical time, Level 4; the underlying commitment process operates in proto-time). The standard (Markovian) equation of motion for the fluctuation is:

$\delta\ddot{\kappa} + \gamma\, \delta\dot{\kappa} + m^2\, \delta\kappa = 0$ (6.1)

with solution decaying as $e^{(-\gamma t/2)} \cos(\Omega t)$, where $\Omega = \sqrt{(m^2 - \gamma^2/4)}$.

6.2 Memory Correction

With the memory kernel active, the equation becomes:

$\delta\ddot{\kappa}(t) + \gamma\, \delta\dot{\kappa}(t) + m^2\, \delta\kappa(t) = \lambda \int_0^t \mathcal{M}\_\mathrm{eff}(t-t')\, \delta\rho(t')\, dt'$ (6.2)

where $\lambda = \delta F/\delta\kappa|\_\{\kappa_0\}$ is the linear response coefficient and $\delta\rho(t')$ is the fluctuation in commitment density sourced by the κ-perturbation itself (a feedback term).

Taking $\delta\rho(t') \propto \delta\kappa(t')$ as the simplest linear feedback, and using the intermediate-time kernel (5.4), one proceeds as follows. Taking the Laplace transform of (6.2) with kernel $\mathcal{M}\_\mathrm{eff}(\tau) \sim \cos(m\tau + \varphi)/(m\tau)$ and substituting the linear feedback relation, the transformed equation has a pole structure at late times dominated by the slowly decaying kernel contribution. Inverting the dominant pole at $s \to 0^+$, the leading late-time correction recovers a t^{-1} envelope modulated by $\sin(mt + \psi)$ — the characteristic signature of a convolution against a τ^{-1} oscillatory kernel acting on an exponentially damped source. The full derivation via Laplace inversion is registered as open problem §8.7; the result at late times ($mt \gg 1$) is:

$\delta\kappa(t) = \delta\kappa\_\mathrm{std}(t) + \delta\kappa\_\mathrm{mem}(t)$ (6.3)

where:

$\delta\kappa\_\mathrm{std}(t) \sim A\, e^{(-\gamma t/2)} \cos(\Omega t)$ (6.4)

$\delta\kappa\_\mathrm{mem}(t) \sim (\lambda\rho_0\delta\kappa_0)/(4\pi m) \cdot \sin(mt + \psi)/t$ (6.5)

The memory correction (6.5) dominates over the standard term (6.4) at times:

$t \gtrsim t^* = (1/\gamma) \ln(4\pi m / (\lambda\rho_0\gamma))$ (6.6)

provided the logarithm is positive, i.e., $4\pi m > \lambda\rho_0\gamma$ (small coupling regime). For $t > t^*$, the system relaxes as t^{-1} rather than exponentially. This is a **qualitative departure from Markovian behaviour**, observable in principle as a distinct long-time tail in any physical process governed by κ-field dynamics.

6.3 Physical Interpretation

Reality is like the surface of a lake. When a rock hits the water, it creates ripples. Those ripples spread out and fade over time — but they never completely disappear. New ripples don't form on a perfectly still surface. They form on a surface that is already carrying the fading traces of every previous disturbance. In the same way, every event in the universe happens in a field that still contains the faint, decaying influence of everything that has happened before.

This image is not merely metaphorical. Each element maps precisely onto the formalism. The rock is a commitment event — irreversible; it cannot be un-thrown. The ripples are the κ-field perturbation propagating via G_ret. The fading but never-vanishing trace is the τ^{-1} interior tail of the massive propagator. And the already-disturbed surface is Ξ(x,t): the accumulated memory field that constitutes the actual dynamical substrate on which each new event occurs.

The shift this implies is structural, not merely quantitative. Standard physics operates on the assumption:

Reality = current state

The present configuration fully determines what happens next. History is encoded in the current state and, once so encoded, is superseded by it. Under the VERSF memory-kernel formulation:

Reality = current state + faint accumulated history

The current state still dominates. But beneath it lies a persistent residue of every prior commitment event, carried forward irreversibly in Ξ. This residue is weak, oscillatory, and partially self-cancelling — but it is never zero and never reset.

The sharpest expression of what changes is this:

Standard physics: two systems with identical present states have identical futures.
VERSF with memory kernel: two systems with identical present states but different commitment histories have slightly different futures.

This is precisely the content of equation (4.2): the history term $\mathcal{K}$ differs between the two systems even when O(t), κ(x,t), and ρ_committed(x,t) are identical. Their futures diverge — not through any violation of local physics, but because the accumulated memory field Ξ is an independent causal variable that the instantaneous state does not encode.

When we say the past "influences" the present, we do not mean it pushes things around like a force. We mean it slightly changes the conditions under which new events happen — shifting probabilities, thresholds, or timing in a way that depends on what has happened before. It is not a dominant effect. It is a subtle bias — a faint memory built into the structure of reality itself. Operationally, this influence is defined as the contribution of the memory term $\mathcal{K}$ in equation (4.2), measurable as the difference in evolution between systems with identical instantaneous states but different commitment histories, and physically manifested as shifts in probabilities, thresholds, or event timing.

Two lakes that look identical on the surface may have different histories of disturbance — and so they respond differently to the next stone.

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7. Physical Regimes

7.1 Low-Density Regime

When ρ_committed is small and slowly varying, the memory correction (6.5) is suppressed by $\lambda\rho_0$. The Markovian approximation is valid and the correction is negligible for practical purposes, consistent with the success of standard Markovian physics in the accessible regime.

7.2 Threshold Proximity

Near the commitment-capacity threshold $\chi(L) \sim 1$ (as defined in the CCC paper [CCC]), the committed-event density approaches a critical value. The linear response coefficient λ diverges as the system approaches threshold, enhancing the memory correction and making it potentially observable in critical slowing-down phenomena.

7.3 High-Density and Extreme Causal Structure

In regimes of high committed-event density — including near-horizon environments of black holes, or in early-universe cosmology — the feedback coupling $\lambda\rho_0$ may become large. In this regime (6.6) implies $t^* \sim \gamma^{-1}$, meaning memory corrections are relevant from the outset and the Markovian approximation fails qualitatively.

This is consistent with the interpretation of Hawking radiation in the companion paper [HR], where the near-horizon geometry is understood as a region of high commitment density and altered κ-field structure.

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8. Open Problems

8.1 The effective mass parameter m in equations (2.1) and (2.3) is treated as a free parameter in this paper. Its derivation from fold-interface dynamics — specifically, from the geometry of the Fold Interface Law — remains an open problem.

8.2 The feedback coefficient $\lambda = \delta F/\delta\kappa$ is introduced phenomenologically in Section 6. A first-principles derivation from the VERSF microscopic action would strengthen the quantitative predictions.

8.3 The model calculation of Section 6 assumes spatially homogeneous perturbations and linear feedback. Extension to spatially inhomogeneous configurations and nonlinear feedback regimes is required for application to structured physical systems.

8.4 The kernel structure derived here applies to the κ-field sector. The analogous memory structure for the gravitational sector — where fold-density gradients source curvature — has not been worked out and may differ.

8.5 No experimental protocol for detecting the t^{-1} relaxation tail is proposed here. Design of a bench-top test — potentially related to the Coupled Temporal protocol [CT] — is left to a companion paper.

8.6 The derivation of the effective τ^{-1} intermediate-regime kernel (5.4) from the point-source $\tau^{-3/2}$ kernel (5.2) via spatial integration over an extended committed-event source is asserted but not demonstrated. A full derivation including the dependence of $\mathcal{M}$_eff on source geometry, the prefactor, and the location of τ_cross is required to put (5.4) on a rigorous footing.

8.7 The step from the integro-differential equation (6.2) to the explicit late-time correction (6.5) is indicated but not derived in detail. A complete derivation via Laplace transform methods, establishing the t^{-1} form and the amplitude coefficient, would strengthen the central quantitative result of the paper.

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9. Conclusion

We have extended the VERSF framework by introducing a **memory kernel formulation of dynamics** and showing that the irreversibility of commitment events gives that kernel a physical status absent from conventional retarded propagators.

The argument runs in three steps.

Step 1. Commitment events source the κ-field irreversibly. The committed-event source only ever grows — committed facts are never de-committed — accumulating causal weight in Ξ despite the oscillatory partial cancellation within the kernel.

Step 2. Two systems with identical instantaneous state but different commitment histories have different values of Ξ and therefore evolve differently. Ξ is an independent dynamical variable. The system is non-Markovian.

Step 3. The memory correction to κ-field relaxation takes an explicit form (6.5) with a t^{-1} tail over the intermediate regime for spatially distributed sources, transitioning to $\tau^{-3/2}$ asymptotically. This tail is qualitatively distinct from Markovian exponential relaxation and constitutes a falsifiable prediction of the framework.

The physical summary is:

Present state = Instantaneous field configuration + Ξ(weighted history of committed facts)

where Ξ is never zero, never reset, and never strictly rendered irrelevant by the passage of time — only progressively attenuated in emergent physical time.

The universe, in this framework, maintains a running ledger. The present is not independent of the past. It is continuously conditioned by it, weakly but persistently, through the irreversibility that defines fact-formation itself.

References

- [FM] Taylor, K. *Fact-Momentum: The κ-Field Stress-Energy Tensor and Irreversible Commitment Events as Sources.* VERSF Theoretical Physics Programme, AIDA Institute.
- [CCC] Taylor, K. *Causal-Coherence Compatibility and the Fact-Production Threshold.* VERSF Theoretical Physics Programme, AIDA Institute.
- [HR] Taylor, K. *Hawking Radiation as Microgeometry Constraint.* VERSF Theoretical Physics Programme, AIDA Institute.
- [CT] Taylor, K. *Coupled Temporal: A Bench-Top Experimental Protocol for VERSF.* VERSF Theoretical Physics Programme, AIDA Institute.
- [NZ1] Nakajima, S. (1958). On quantum theory of transport phenomena. *Progress of Theoretical Physics*, 20(6), 948–959.
- [NZ2] Zwanzig, R. (1960). Ensemble method in the theory of irreversibility. *Journal of Chemical Physics*, 33(5), 1338–1341.
- [V] Volterra, V. (1930). *Theory of Functionals and of Integral and Integro-Differential Equations.* Blackie & Son, London.