Special VLCC Section – Lagrangian V.8

Morphogenic Theory of Time: Renormalised Lagrangian, LRQT, and Emerging Gravity

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Toulouse – November 2025

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Summary

The VLCC V.8 model proposes a fundamental reformulation of cosmological and gravitational dynamics by introducing a real time field $\sigma(x)$, which carries the internal structure of time.

In this framework, time is no longer an external parameter, but a physical entity possessing a morphogenic density, an internal tension and a trinitarian structure (t_1, t_2, t_1') governed by a fundamental asymmetry Δt.

Lagrangian V.8 combines a morphogenic Planck mass tensor sector $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$, a renormalised scalar sector for $\sigma(x)$, a stabilising potential and a boundary term ensuring variational consistency, placing the dynamics in the class of emerging scalar-tensor theories.

Version V.8 also introduces a major conceptual contribution: the Law of Quantum Relativity of Time (LRQT).

This law establishes that local quantum dynamics do not depend on classical coordinated time, but on an effective quantum time $\tau_q = dt / (1 + \alpha \Delta t)$, determined by the internal morphogenesis of time.

The LRQT thus links the evolution of quantum systems to the temporal tension Δt, paving the way for internal frequency variations, phase accelerations, and a direct dependence between quantum dynamics, time memory, and cosmological structure.

In an FLRW metric, the model produces modified Friedmann equations where cosmological evolution explicitly depends on $\sigma(t)$ via $M_{eff}(t)$.

Effective solutions include kinetic, potential, quasi-stationary regimes and morphogenic attractors, allowing for a detailed classification of temporal and gravitational behaviours.

General Relativity is rigorously recovered when $\Delta t \to 0$ and $\sigma \to$ constant, ensuring the model's consistency with experimental tests and standard tensor dynamics.

VLCC V.8 thus presents itself as a coherent extension of gravity, unifying the internal structure of time, cosmological dynamics and quantum evolution via LRQT.

Introduction

The VLCC (Variable Lagrangian of Cosmic Chronotropy) model proposes a profound reformulation of the role of time in fundamental physics.

Unlike traditional approaches, where time is treated as an external, homogeneous and passive parameter, VLCC posits that time has an internal dynamic structure carried by a real field $\sigma(x)$.

This structure is based on a tripartite organisation of the temporal flow — memory t_1, the entangled present t_2 and future tension t_1' — linked by a fundamental asymmetry $\Delta t = t_1' - t_1$.

This asymmetry constitutes the morphogenic arrow of time and determines its local and global properties.

Version V.8 of the model introduces several major theoretical advances.

It proposes a renormalised Lagrangian explicitly integrating the temporal triad, a scalar–tensor coupling via a morphogenic Planck mass $M\_eff^2 = M\_Pl^2 + 2\chi\sigma^2$, a stabilising potential $V(\sigma)$, and a boundary term guaranteeing variational consistency.

This formulation yields the Euler–Lagrange equations of the σ field and geometry, leading to an emergent gravity arising from the internal dynamics of time rather than from a metric postulated as primitive.

An essential contribution of version V.8 is the formal introduction of the fourth fundamental law of VLCC: **the Law of Quantum Relativity of Time (LRQT).**

This law establishes a direct and unprecedented link between the morphogenesis of time and the evolution of quantum systems.

It asserts that local quantum evolution does not depend on classical coordinated time dt, but on effective quantum time defined by:

$d\tau\_q = dt / (1 + \alpha\, \Delta t)$.

The LRQT thus shows that quantum dynamics is conditioned by the temporal tension Δt and by the internal state of the temporal field.

It complements the three existing fundamental laws (LPHD, LCFT, LRTG) and is a key element of the time-gravity-quantum unification proposed by the VLCC.

The rest of the article successively presents Lagrangian formalism, the associated field equations, their cosmological implications in FLRW metric, the effective solutions obtained, and how the model rigorously recovers General Relativity in the limit $\Delta t \to 0$ and $\sigma \to$ constant.

This structure establishes VLCC V.8 as a coherent extension of gravity, based on an internal dynamics of time and now integrating LRQT as a fundamental principle linking temporal morphogenesis and quantum phenomena.

2. Theoretical context and motivations

The VLCC model is part of a set of open questions in fundamental physics: the nature of time, the origin of gravity, the role of light in cosmological coherence, and the behaviour of the vacuum on a large scale.

It proposes treating time not as an external, passive parameter, but as a real physical field with its own internal structure and dynamics.

Classical frameworks, from Newtonian mechanics to general relativity, consider time to be homogeneous, universal, or simply coordinated.

Quantum mechanics, for its part, does not attribute observable status to time: time remains a variable of evolution imposed from outside.

This asymmetry between time and other physical quantities leaves open the question of whether time is a true dynamic entity or simply a descriptive parameter.

The VLCC adopts the first option.

It postulates the existence of a temporal field $\tau(x)$, linked to a normalised dimensionless variable $\sigma(x)$ by $\tau(x) = \tau_* \sigma(x)$. This field is not homogeneous: it has a morphogenic density, an internal tension and a trinitarian structure of temporal flow, organised into memory t_1, entangled present t_2 and future tension t_1'.

The fundamental asymmetry $\Delta t = t_1' - t_1$ characterises the morphogenic arrow of time.

A central conceptual point of the model is that the present state t_2 is not a simple average between past and future.

It results from a non-separable morphogenic entanglement between t_1 and t_1', determined by the dynamics of the temporal field. Time is therefore no longer a passive axis, but an organised system that is constantly reconfiguring itself under the effect of this entanglement.

This framework naturally leads to a reinterpretation of gravity.

Rather than postulating a primitive geometric curvature, the VLCC proposes that gravity emerges from internal variations in the temporal field, via a morphogenic Planck mass $M_{eff}(\sigma)$.

The minimal form retained in version V.8, $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$, is chosen as the simplest quadratic extension compatible with stability, renormalizability, and standard scalar-tensor theories. More complex generalisations $f(\sigma)$ will be studied in future work.

Similarly, the choice of a polynomial-type morphogenic potential $V(\sigma) = V_0 + 1/2\ m^2 \sigma^2 + \lambda \sigma^4$ meets the requirements of simplicity and efficiency: it is the minimum renormalizable potential allowing the existence of attractor states for temporal organisation. It serves as a reference model, intended to be refined in the rest of the VLCC programme.

Beyond classical gravity, the model also aims to link the internal structure of time to quantum phenomena.

It is with this in mind that version V.8 introduces the Law of Quantum Relativity of Time (LRQT), which establishes an explicit link between temporal morphogenesis and the evolution of quantum systems.

This law postulates the existence of an effective quantum time $d\tau_q$, distinct from classical coordinated time dt, and dependent on asymmetry Δt.

Δt is not a local degree of freedom but a global structure parameter; its local influence appears only via the kinetic coefficient K_{tot}.

The internal quantum frequency ω of a system depends on a morphogenic parameter proportional to Δt.

In this case, the LRQT law is obtained by noting that the contraction of the internal phases naturally leads to a time derivative $d\tau_q$ consistent with the slowdown induced by Δt.

Δt encodes a cosmological boundary asymmetry, such as the low-entropy initial condition of the Universe. This is not a local degree of freedom: it is a structure parameter, analogous to the orientation of the arrow of time.

It paves the way for a unified interpretation of quantum dynamics, the temporal field, and emergent gravity.

Overall, the context section places VLCC at the crossroads of several issues: the ontological nature of time, the emergence of gravity, deep luminous coherence, and cosmological evolution.

Version V.8 formalises these intuitions in a renormalised Lagrangian framework, where the minimal choices for $M_{eff}(\sigma)$, $V(\sigma)$ and the dependence on Δt are explicitly set as first approximations, intended to be generalised in future versions of the model.

3. Foundations of the VLCC model

This section outlines the founding principles of the latest version of the model.

It presents the morphogenic structure of time, the definition of the temporal field $\sigma(x)$, the temporal triad (t_1, t_2, t_1'), the asymmetry Δt, as well as the four fundamental laws, the last of which, the Law of Quantum Relativity of Time (LRQT), is one of the major contributions of version V.8.

3.1. Time as a physical field

Within the VLCC framework, time is not an external parameter, but a real physical field $\tau(x)$.

In order to work in a dimensionless formalism compatible with the Lagrangian, we introduce the normalised field:

$\sigma(x) = \tau(x) / \tau_*$,

where τ_* is a scale constant.

The field $\sigma(x)$ represents the morphogenic density and the internal state of the temporal flow. It is dimensionless, normalised and carries the fundamental temporal dynamics.

3.2. The triune structure of the temporal flow

Time is organised into a non-linear and intricately linked triad:

– t_1: morphogenic memory (condensed past),

– t_2: entangled present,

– t_1': future tension (anticipation).

Contrary to a naive interpretation, t_2 is not an average between t_1 and t_1'.

It results from an inseparable morphogenic entanglement between these two components. This entanglement forms the very basis of the internal dynamics of time.

3.3. The morphogenic asymmetry Δt

K_tot intervenes in the dynamics of the temporal field $\sigma(x)$ and encodes the effect of the morphogenic shift Δt.

In version V.8, it is defined by:

$K\_tot = 1 + (\alpha + 2\lambda\_m)\,\Delta t.$

This expression explicitly constitutes the first-order linear development in Δt, valid within the limit $|\Delta t| \ll 1$ relevant to contemporary cosmology.

Δt is not a dynamic field but a global, unvarying parameter measuring the fundamental asymmetry between the morphogenic memory t_1 and the future tension t_1'.

Although global in its definition, Δt acts locally through K_tot, which directly multiplies the kinetic term of the field $\sigma(x)$.

Δt encodes a cosmological boundary asymmetry, comparable to the low-entropy initial condition of the Universe.

This is not a local degree of freedom, but a structural parameter of the cosmos, analogous to the orientation of the arrow of time.

This global/local articulation will be decisive in the analyses in sections 6 and 7.

3.4. The temporal field and the morphogenic Planck mass

Variations in $\sigma(x)$ modify gravity via a morphogenic Planck mass defined by:

$M\_eff^2 = M\_Pl^2 + 2\chi\,\sigma^2.$

The chosen quadratic form constitutes the minimal extension ensuring stability, absence of ghosts (for $\chi > 0$) and compatibility with classical scalar–tensor theories.

It is sufficiently general to capture morphogenic effects while remaining simple. Generalisations $f(\sigma)$ will be explored in version V.9.

3.5. The morphogenic potential V(σ)

The potential of the temporal field is chosen in the form:

$V(\sigma) = V_0 + 1/2\ m^2\ \sigma^2 + \lambda\ \sigma^4$.

This minimal polynomial potential is renormalizable and has morphogenic attractors that stabilise temporal dynamics.

It constitutes a simple reference model, intended to be made more complex in future versions of the VLCC.

3.6. The three fundamental laws of VLCC

The fundamental laws preceding the LRQT are:

1. LPHD – Law of Temporal Flow Plasticity: time is a deformable flow governed by σ(x).

2. LCFT – Law of Fundamental Time–Gravity Coupling: gravity emerges from variations in σ via M_eff.

3. LRTG – Law of Temporal Renormalisation of Gravity: gravitational inertia depends on the internal state of time.

These laws structure the temporal and gravitational dynamics of the model.

3.7 LRQT Law — Quantum Relativity of Time

Section 3.7 formally introduces the fourth fundamental law of the VLCC model: **the Law of Quantum Relativity of Time (LRQT)**.

This law is one of the major contributions of version V.8, as it establishes for the first time a direct link between the internal structure of time and the quantum evolution of physical systems.

3.7.1 Conceptual motivation for the LRQT

In classical theories, time is an external, homogeneous and universal parameter. In

quantum mechanics, it is not an operator but an imposed variable.

The VLCC breaks with this view by establishing that time is a real physical field τ(x), possessing morphogenic density, internal tension, non-linear dynamics, a trinitarian structure (t_1, t_2, t_1') and intrinsic asymmetry $\Delta t = t_1' - t_1$.

In such a framework, quantum evolution must depend on the local state of the time field. It is this need for internal consistency that motivates the LRQT.

3.7.2 General formulation of LRQT

LRQT states that: "Local quantum evolution occurs according to an effective time $d\tau\_q$ determined by the morphogenic asymmetry of time."

In version V.8, the relationship adopted is:

$d\tau\_q = dt / (1 + \alpha \Delta t)$.

The internal quantum frequency ω of a system depends on a morphogenic parameter proportional to Δt.

In this case, the LRQT law is obtained by noting that the contraction of the internal phases naturally leads to a time derivative $d\tau\_q$ consistent with the slowdown induced by Δt.

3.7.3 Physical interpretation

Quantum time depends on the internal structure of the time flow: memory (t_1), future tension (t_1') and entangled present (t_2).

A high t_1 slows down quantum evolution, a high t_1' accelerates it, while an intense t_2 modifies the phases without altering the fundamental speed.

This dependence acts as a "temporal refraction" observable on quantum phases.

3.7.4 Consequences for quantum systems

1. Cosmological variation of effective quantum constants: frequencies, characteristic durations and decoherences vary with Δt.

2. Quantum-morphogenic transition: regions dominated by t_1' see systems evolve faster than in standard quantum mechanics.

3. Expansion-quantum coupling: an increase in Δt accelerates the internal evolution of systems.

4. Decorrelation from the past: as t_1 decreases, Δt increases, reinforcing quantum effects.

3.7.5 Compatibility with the LPHD, LCFT and LRTG laws

The LRQT complements the three fundamental laws of VLCC: LPHD (time flow plasticity), LCFT (field-time–gravity coupling) and LRTG (time–mass relation).

It does not replace any law: it extends them by introducing quantum dependence on temporal morphogenesis.

3.7.6 Ultra-relativistic variant

For extreme asymmetries $\Delta t \gg 1$:

$d\tau_q \approx dt / (\alpha \Delta t)$.

The future tense then completely dominates internal development.

3.7.7 Summary of LRQT

LRQT establishes that quantum dynamics depend on temporal morphogenesis and not on external time.

It forms a bridge between microscopic quantum physics and cosmic temporal organisation.

In version V.8, it becomes a cornerstone linking gravity, time and quantum phenomena.

In version V.8, LRQT is formulated in the first order in Δt. A non-linear generalisation will be proposed in V.9.

3.8. Summary of the fundamentals

In VLCC V.8, time is a structured dynamic field, whose inseparable entanglement between memory and anticipation (t_1, t_1') generates the present t_2. The asymmetry Δt determines morphogenic inertia and the kinetic coefficient K_{tot}, while the morphogenic Planck mass M_{eff} and the potential $V(\sigma)$ organise emerging gravity.

The introduction of LRQT reinforces this structure by directly linking quantum dynamics to temporal morphogenesis.

Together, they form a coherent, stable and extensible basis for the dynamics of time, gravity and quantum phenomena.

Here, dt is the classical coordinated time, α is a morpho-quantum coefficient, and Δt is the overall time shift.

When Δt increases, quantum time contracts: internal oscillations accelerate, phases evolve more quickly, and decoherence is reinforced.

4. Complete variational action of the model

This section presents the complete formulation of Lagrangian V.8, incorporating all the conceptual and technical corrections from the previous sections.

The objective is to construct a renormalizable action that is consistent and compatible with the four fundamental laws, including LRQT, which links quantum dynamics to the morphogenesis of time.

4.1. General structure of action

The total action of the VLCC model is given by:

$$S = \int d^4x \sqrt{(-g)} \left[(1/2) M_{eff}^2 R - (1/2) K_{tot} g^{\mu\nu} \partial_\mu \sigma \partial_\nu \sigma - V(\sigma) \right] + S_{border}.$$

It contains three contributions:

– the gravitational sector emerging via the morphogenic Planck mass $M_{eff}(\sigma)$,

– the kinetic sector of the time field $\sigma(x)$,

– the morphogenic potential $V(\sigma)$,

to which is added a boundary term S_{bord} guaranteeing variational consistency.

Intuitively, the term σR establishes a direct link between geometric curvature and the morphogenic density of time: as σ increases, the effective contribution to curvature strengthens and modifies the dynamic response of space-time.

This coupling constitutes the fundamental variational mechanism linking geometry and temporal morphogenesis.

4.2. Morphogenic Planck mass

The effective Planck mass results from internal variations in the time field: $M\_eff^2(\sigma) =$

$M\_Pl^2 + 2\chi \sigma^2$.

This quadratic form constitutes the minimal stable and renormalizable extension. The choice χ
> 0 eliminates any phantom modes: the derived kinetic term remains strictly positive, ensuring the stability of the tensor sector. Generalisations $f(\sigma)$ will be considered in version V.9.

The condition $\chi > 0$ is necessary to guarantee the absence of ghost modes, which ensures the stability of the tensor sector.

4.3. Kinetic term and linear development in Δt

The total kinetic coefficient is given by:

$K\_tot = 1 + (\alpha + 2\lambda\_m) \Delta t$.

This is explicitly the first-order linear development in Δt, valid in the limit $|\Delta t| \ll 1$, compatible with the morphogenic regime accessible in the observable Universe. Non-linear effects will be studied in future work.

4.4. Morphogenic potential

The potential is chosen in the minimal renormalizable form:

$V(\sigma) = V_0 + 1/2\ m^2 \sigma^2 + \lambda \sigma^4$.

This potential has morphogenic attractors and provides a simple basis for analysing the internal dynamics of time. It will serve as a reference model, with more complex forms being reserved for version V.9.

4.5. Boundary term

The boundary term S_boundary is added to ensure that the variation in action remains well defined under variation in the metric and the field $\sigma(x)$.

It generalises the Gibbons–Hawking–York term by including morphogenic dependence.

4.6. Consistency with the four fundamental laws

The Lagrangian V.8 naturally encodes:

– the LPHD (time flow plasticity) via the kinetic sector,

– LCFT (time–gravity coupling) via $M_{eff}(\sigma)$,

– LRTG (temporal renormalisation of gravity) thanks to the internal dependence of σ,

– the LRQT (quantum relativity of time) as an effective law linking $d\tau_q$ to Δt.

4.7. Summary of the Lagrangian structure

The Lagrangian V.8 captures the entire internal dynamics of time: the morphogenic Planck mass encodes gravitational emergence, the kinetic term expresses temporal plasticity, the potential stabilises morphogenesis, and the LRQT links this dynamic to quantum evolution.

This structure forms the mathematical basis of the entire VLCC model in its V.8 version.

5. Euler–Lagrange equations

This section derives the variational equations from the V.8 action of the VLCC model.

They govern the joint dynamics of the temporal field σ(x) and the geometry $g_{\mu\nu}$. The formulation respects variational consistency thanks to the boundary term and naturally integrates the morphogenic structure introduced in the previous sections.

5.1. Variation with respect to the time field σ(x)

This subsection establishes the Euler–Lagrange equation derived from the variation of the action of the VLCC V.8 model with respect to the time field σ(x), taking into account the non-dynamic status of the morphogenic slip Δt.

The action considered is:
$S = \int d^4x \sqrt{-g} \, [(1/2) M_{eff}^2 R - (1/2) K_{tot} g^{\mu\nu} \partial_\mu \sigma \partial_\nu \sigma - V(\sigma)]$.

The variation leads to the general equation:
$\Box\sigma + (\partial_\mu \ln K_{tot})\, \partial^\mu \sigma - (1/K_{tot})\, \partial V/\partial\sigma + (\chi/K_{tot})\, \sigma R = 0.$

In version V.8, the kinetic coefficient is:
$K_{tot} = 1 + (\alpha + 2\lambda_m)\, \Delta t$, a first-order linear expansion for $|\Delta t| \ll 1$. Since Δt is a global parameter that does not vary, we have:
$\partial_\mu K_{tot} = 0.$

The term $(\partial_\mu \ln K_{tot})\, \partial^\mu \sigma$ is therefore identically zero in all local contexts (FLRW, quasi-static, weak dynamics).

Nevertheless, it is retained in the general expression in order to maintain the complete form of the variational equation.

The effective equation then becomes:
$\sigma - (1/K_{tot})\, \partial V/\partial\sigma + (\chi/K_{tot})\, \sigma R = 0.$

This equation governs the morphogenic propagation of $\sigma(x)$ in the cosmological contexts studied.

5.2. Variation with respect to the metric $g_{\mu\nu}$

The variation of the action with respect to the metric leads to the generalised gravitational equations:

$$M_{eff}^2\, G_{\mu\nu} = T^{(\sigma)}_{\mu\nu} + \chi\, (\nabla_\mu\nabla_\nu - g_{\mu\nu} \Box)\, \sigma^2 - g_{\mu\nu}\, V(\sigma).$$

The energy–momentum tensor of the temporal field is written as:

$$T^{(\sigma)}_{(\mu\nu)} = K_{(tot)}\, (\partial_\mu \sigma\, \partial_\nu \sigma - 1/2\, g_{(\mu\nu)}\, \partial_\alpha \sigma\, \partial^\alpha \sigma).$$

These equations show that:
– gravity emerges from variations in σ via $M_{eff}^2(\sigma)$,
– temporal morphogenesis directly influences the metric through the second derivatives of σ^2,
– stability is ensured by the condition $\chi > 0$ (absence of ghosts).

5.3. Conservation condition

As in any theory with diffeomorphic invariance, the conservation equation:

$\nabla^\mu (T^{(\sigma)}_{\mu\nu} + T^{(geom)}_{\mu\nu}) = 0$, is automatically satisfied if the Euler–Lagrange equations are verified.

This guarantees the variational self-consistency of the model and the absence of incompatible terms between geometry and temporal dynamics.

5.4. Morphogenic interpretation

The derived equations have a clear interpretation:

– temporal morphogenesis drives gravitational emergence via $M_{eff}(\sigma)$,

– the deformable temporal flow is controlled by K_{tot}, which is sensitive to asymmetry Δt,

– Future tension and memory (t_1', t_1) influence the propagation of σ through Δt,

– LRQT intervenes in the background by linking Δt to quantum processes.

5.5. Summary of variational dynamics

As introduced in section 3.7, the Quantum Relativity of Time Law (LRQT) directly links the morphogenic asymmetry Δt to the effective quantum time by:

$d\tau_q = dt / (1 + \alpha \Delta t)$.

In version V.8, this relation is formulated to first order in Δt. It does not add any additional variational terms to the action, but it provides the conceptual framework necessary for the quantum interpretation of the solutions of the field $\sigma(x)$.

It guarantees consistency between classical morphogenetic dynamics, internal temporal structure, and local quantum evolution.

6. FLRW cosmology in VLCC

This section applies the Lagrangian formalism of the VLCC V.8 model to the cosmological context in FLRW geometry.

The objective is to study the dynamics of the temporal field $\sigma(t)$, the evolution of the morphogenic Planck mass M_eff(t), and the modifications made to Friedmann's equations by temporal morphogenesis.

6.1. Cosmological assumptions

We consider a spatially flat FLRW metric:

$ds^2 = -dt^2 + a(t)^2 \, d\vec{x}^2$.

In this homogeneous and isotropic framework, the time field becomes purely

scalar: $\sigma = \sigma(t)$.

The temporal triad (t_1, t_2, t_1') does not vary locally but influences the overall dynamics through the asymmetry Δt.

6.2. Dynamic morphogenic Planck mass

The effective Planck mass depends on the time field:

$M\_eff^2(t) = M\_Pl^2 + 2\chi \, \sigma(t)^2$.

This expression guarantees stability, absence of ghosts, and compatibility with scalar-tensor theories. The temporal variation of $\sigma(t)$ causes a slow variation of M_eff(t), inducing a progressive renormalisation of cosmic gravity.

6.3. Time field equation in FLRW regime

By limiting K_tot to the linear expansion valid for $|\Delta t| \ll 1$, i.e.: K_tot = 1

$+ (\alpha + 2\lambda\_m) \, \Delta t$,

the dynamic equation of the time field becomes: $\ddot{\sigma}$

$+ 3H \dot{\sigma} + (1 / K\_tot) \, dV/d\sigma - (\chi / K\_tot) \, \sigma R = 0$.

The evolution of $\sigma(t)$ therefore depends on:

– the expansion rate H,

– the form of the morphogenic potential,

– the curvature feedback via the term σR.

6.4. Modification of Friedmann's equations

The modified cosmological equations are:

$$3 M_{eff}^2 H^2 = \rho_\sigma + V(\sigma) - 3\chi H d(\sigma^2)/dt,$$

$$-2 M_{eff}^2 \dot{H} = \rho_\sigma + p_\sigma + \chi d^2(\sigma^2)/dt^2 + 2\chi H d(\sigma^2)/dt.$$

where the contributions of the temporal field are:
$\rho_\sigma = 1/2\ K_{tot}\ \dot{\sigma}^2$, $p_\sigma = 1/2\ K_{tot}\ \dot{\sigma}^2$.

These equations show that $\sigma(t)$ acts as a dynamic gravitational source whose influence depends on the internal morphogenesis of time.

6.5. Emerging cosmological behaviours

The possible solutions can be divided into several regimes:

1. Kinetic regime: $\dot{\sigma}^2$ dominant — low acceleration, quasi-stiff dynamics.
2. Potential regime: $V(\sigma)$ dominant — analogous to slow morphogenic inflation.
3. Quasi-stationary regime: $\sigma \approx$ constant — gravity close to General Relativity.
4. Morphogenic attractors: combination of kinetics + potential giving $M_{eff} \to$ constant.

In each of these regimes, the value of Δt influences the intensity of the effect of $\sigma(t)$ on gravity via K_{tot}.

6.6. Cosmological role of LRQT

In accordance with section 3.7, the Quantum Relativity of Time Law expresses: $d\tau\_q = dt / (1 + \alpha\, \Delta t)$, a relationship valid to the first order in Δt in version V.8.

This relation implies that:
– $\Delta t > 0$ contracts quantum time and accelerates microscopic evolution;
– $\Delta t < 0$ dilates $d\tau\_q$ and slows down quantum processes;
– when $\Delta t \to 0$, standard quantum mechanics is exactly recovered.

In an FLRW context, this quantum time modulation can influence primordial fluctuations, phase transitions, and microscopic scales coupled to cosmological morphogenesis.

6.7. Cosmological synthesis

In FLRW geometry, temporal morphogenesis modifies gravity via M_eff(t), influences the flow of time via K_tot, and renormalises quantum evolution via LRQT.

The resulting cosmological equations offer a rich, coherent dynamic capable of describing regimes ranging from morphogenic inflation to late attractors, while recovering General Relativity when $\Delta t \to 0$ and $\sigma \to$ constant.

7. Time slip and local dynamics

This section analyses the central role of morphogenic asymmetry Δt in the dynamics of the VLCC V.8 model.
Δt is not a field but a global parameter characterising the fundamental asymmetry of the temporal flow.
It encodes the gap between the morphogenic memory t_1 and the future tension t_1', structuring the temporal entanglement that gives rise to the entangled present t_2.

7.1. Definition of morphogenic asymmetry

The fundamental morphogenic asymmetry of time is defined by: $\Delta t = t_1' - t_1$.

Δt is not a dynamic field but a global, unvarying parameter measuring the irreducible asymmetry between memory (t_1) and future tension (t_1').

Although global, Δt exerts local effects by modulating the kinetic coefficient: $K\_tot = 1 + (\alpha + 2\lambda\_m)\ \Delta t$.

Thus, morphogenic slippage is global in its definition but local in its dynamic consequences, directly influencing the propagation of the temporal field $\sigma(x)$.

7.2. Total kinetic coefficient K_tot

The kinetic coefficient appears in the Lagrangian through:

$K\_tot = 1 + (\alpha + 2\lambda\_m)\ \Delta t$.

This explicitly refers to the first-order linear development valid for $|\Delta t| \ll 1$, which is the relevant limit for the observable universe.

This approximation ensures that only the main contribution of morphogenic drift is involved in the effective dynamics.

Non-linear effects will be addressed in version V.9 of the model.

7.3. Influence of Δt on the dynamics of the time field

Morphogenic drift intervenes in the equation of the field $\sigma(t)$ in particular by:

– modifying the kinetic weight via K_tot,

– an indirect influence on morphogenic stabilisation by the potential $V(\sigma)$,

– modulation of field propagation in cosmology.

A high Δt reinforces kinetic effects and can accelerate the dynamics of the temporal field, leading to more reactive or unstable regimes.

A low or negative Δt tends to slow down dynamics, favouring morphogenic attractors.

7.4. Gravitational implications

The Δt shift indirectly modifies gravity via:

– the kinetic renormalisation of the σ field,

– the induced variation on $M_{eff}(\sigma)$,

– the feedback σR in the Euler–Lagrange equations.

In regimes where Δt is small, gravity approaches General Relativity.

When Δt is larger, the variation in σ can lead to measurable cosmological deviations, particularly in early regimes.

7.5. Role of Δt in LRQT

The Quantum Relativity of Time Law states that:

$d\tau_q = dt / (1 + \alpha \Delta t)$.

Thus, Δt contracts or dilates effective quantum time.

In regions or periods where t_1' dominates, $\Delta t > 0$ contracts $d\tau_q$ and accelerates quantum processes. When t_1 dominates, $\Delta t < 0$ lengthens $d\tau_q$ and slows down quantum evolution. Δt therefore constitutes the direct link between quantum dynamics, time memory and future tension.

7.6. Time regimes induced by Δt

There are several regimes driven by variations in Δt:

1. Sub-linear regime: $|\Delta t| \ll 1$ — domination of the entangled present, close to the GR regime.
2. Tension regime: $\Delta t > 0$ — acceleration of the σ field and contraction of quantum time.
3. Memory regime: $\Delta t < 0$ — slowing down of σ and amplification of residual effects.
4. Critical regime: $\Delta t \to$ non-linear values — area to be explored in V.9.

7.7. Summary

The morphogenic shift Δt is a central parameter of VLCC V.8.

It organises the relationship between memory t_1 and future tension t_1', structures kinetic behaviour via K_tot, influences gravity through M_eff(σ) and links morphogenic time to quantum time via LRQT.

This structuring makes Δt one of the conceptual pillars of the model, determining the internal dynamics of time, gravitational renormalisation and local quantum evolution.

8. Effective solutions and associated phenomena

This section examines the effective solutions derived from the cosmological equations of the VLCC V.8 model.

It presents the characteristic dynamic regimes induced by the combination of the time field σ(t), the morphogenic Planck mass M_eff(t), the kinetic coefficient K_tot and the morphogenic potential V(σ).

These regimes structure cosmological evolution and make it possible to distinguish between the behaviours expected in different morphogenic scenarios.

8.1. General framework of solutions

The modified cosmological equations derived in Section 6 produce a rich dynamic whose structure depends essentially on three contributions:

– the kinetics of the time field, controlled by K_tot $\dot{\sigma}^2$;

– the morphogenic potential V(σ);

– gravitational renormalisation via M_eff(t).

When Δt is small ($|\Delta t| \ll 1$), the dynamics are close to those of classical scalar-tensor models.

When Δt increases, morphogenic effects become dominant and qualitatively structure the solution.

8.2. Kinetic regime

This regime appears when the energy is dominated by the kinetic part of the

temporal field:

$\rho_\sigma \approx 1/2\ K_{tot}$

$\dot{\sigma}^2$.

Characteristics:

– σ evolves rapidly;

– $M_{eff}(t)$ varies moderately;

– the expansion is quasi-stiff ($w \approx +1$).

A positive Δt further reinforces the dynamics, which can produce highly reactive phases of evolution in the temporal field.

8.3. Potential regime

When the potential $V(\sigma)$ dominates, the dynamics become analogous to slow morphogenic inflation:

$\rho_\sigma \approx V(\sigma)$.

Characteristics:

– $\dot{\sigma}$ becomes weak;
– $M_{eff}(t)$ tends towards a quasi-constant value;
– the expansion approaches a quasi-exponential regime.
This regime is particularly sensitive to the form chosen for $V(\sigma)$.

8.4. Quasi-stationary regime

This regime is reached when $\sigma(t)$ varies very little over time: $\dot{\sigma}$

≈ 0, $\sigma \approx \sigma_0$ (constant).

Consequences:

– the morphogenic Planck mass becomes constant: $M_{eff} \rightarrow M_{Pl}$,
– gravity is reduced to General Relativity,
– the dynamics no longer depend on Δt in the first order.

This is a structural attractor of the model, ensuring compatibility with modern gravitational tests.

8.5. Mixed regimes and morphogenic attractors

VLCC V.8 allows for mixed solutions where kinetics and potential contribute simultaneously:

– kinetics governs the variation of σ,
– potential stabilises morphogenesis,
– M_{eff} gradually approaches a fixed value.

These solutions constitute morphogenic attractors that are particularly important for late cosmology.

8.6. Influence of Δt on dynamic regimes

The asymmetry Δt drives transitions between regimes:

– $\Delta t > 0$ amplifies kinetic effects and accelerates convergence towards attractors;
– $\Delta t < 0$ slows down dynamics and reinforces memory regimes;
– $|\Delta t| \ll 1$ places the model in a dynamic close to GR.

In early regimes, a high Δt can induce rapid temporal fluctuations, influencing cosmological phase transitions.

8.7. Transversal role of LRQT

LRQT acts as an effective quantum correction: $d\tau_q = dt / (1$

$+ \alpha \Delta t)$.

In kinetic regimes:

– quantum time contraction,
– accelerated evolution of quantum phases.

In quasi-steady-state regimes:
– $d\tau_q \approx dt$,
– standard quantum mechanics is recovered.

LRQT reinforces the coherence between morphogenetic dynamics, cosmology and microscopic phenomena.

8.8. Summary of solutions

The solutions of VLCC V.8 are divided into kinetic, potential, stationary and mixed regimes, all structured by the variation of $\sigma(t)$ and $M_{eff}(t)$.

The asymmetry Δt modulates the entire dynamic via K_{tot} and intervenes in quantum evolution via LRQT.

This hierarchical structure provides a coherent description of the Universe, ranging from early morphogenic regimes to phases close to General Relativity.

9. Theoretical limits and GR consistency

This section establishes how the VLCC V.8 model recovers General Relativity within the appropriate limits, characterises morphogenic attractors, and specifies the conditions of internal consistency that guarantee the stability and dynamic robustness of the model.

9.1. GR limit: $\Delta t \rightarrow 0$ and $\sigma \rightarrow$ constant

General Relativity is rigorously recovered when:

– morphogenic asymmetry tends towards zero: $\Delta t \rightarrow 0$,

– the temporal field reaches a steady state value: $\sigma(t) \rightarrow \sigma_0$. In

this configuration:

– the kinetic coefficient becomes $K_{tot} \rightarrow 1$,

– the morphogenic Planck mass freezes: $M_{eff}^2 \rightarrow M_{Pl}^2 + 2\chi\, \sigma_0^2$,

– the dynamic contributions of σ cancel out in the Euler–Lagrange equations. The

metric then satisfies the ordinary Einstein equations:

$G_{\mu\nu} = (1 / M_{eff}^2)\, T_{\mu\nu}$.

This clean and complete recovery of General Relativity guarantees the model's compatibility with all local and astrophysical gravitational tests.

9.2. Morphogenic attractors

The VLCC V.8 model admits several fundamental attractors:

1. Stationary attractor: $\sigma \approx$ constant

   – M_eff stabilises,
   – gravity becomes equivalent to GR,
   – Δt loses its influence in the first order.

2. Damped kinetic attractor: $\dot{\sigma} \to 0$ but σ variable

   – kinetics decrease faster than the potential contribution,
   – the dynamics converge towards a quasi-potential regime.

3. Mixed attractor: kinetic/potential combination

   – convergence towards an effective value of M_eff,
   – possible stabilisation of Δt.

These attractors ensure the long-term dynamic robustness of the model.

9.3. Role of Δt in attractors

Morphogenic slippage influences access to attractors:

– $\Delta t > 0$ accelerates convergence towards steady states,
– $\Delta t < 0$ slows down the dynamics and can generate prolonged memory phases.

In both cases, the dynamics remain stable as long as $|\Delta t| \ll 1$, a condition corresponding to the observable morphogenic regime.

9.4. Variational consistency and conservation

Thanks to the boundary term and the structure of the action, conservation:

$$\nabla^\mu \left(T^{(\sigma)}_{\mu\nu} + T^{(geom)}_{\mu\nu}\right) = 0$$

is automatically satisfied when the Euler–Lagrange equations are respected.

This property guarantees the self-consistency of the model and the absence of incompatibilities between geometry and temporal dynamics.

9.5. Consistency with LRQT

The LRQT imposes: $d\tau_q = dt / (1 + \alpha \Delta t)$.

In attractor regimes where $\Delta t \to 0$, $d\tau_q \to dt$ and standard quantum mechanics is fully restored.

In transient regimes, the contraction or dilation of $d\tau_q$ constitutes a sub-dominant but conceptually essential effect
sub-dominant but conceptually essential effect, ensuring continuity between quantum dynamics and temporal morphogenesis.

9.6. Summary

The VLCC V.8 model is consistent with General Relativity within its stationary limits, possesses stable morphogenic attractors, and maintains variational self-consistency.

The presence of LRQT provides a solid conceptual link between the internal dynamics of time, gravity and quantum phenomena, consolidating the theoretical architecture of the model at all relevant scales.

General summary

The VLCC V.8 model proposes a unified reformulation of gravitational, cosmological and quantum dynamics by placing the internal structure of time at the heart of fundamental physics.

Unlike traditional approaches where time is an external parameter, VLCC describes it as a real field $\sigma(x)$, with its own dynamics and organised according to a tripartite structure: memory t_1, entangled present t_2 and future tension t_1'.

The morphogenic asymmetry $\Delta t = t_1' - t_1$, a global parameter that does not vary, encodes the internal arrow of time and guides all the physical processes described by the model.

Version V.8 introduces a unified Lagrangian that explicitly integrates this temporal structure.

It combines a scalar–tensor coupling via a morphogenic Planck mass $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$, a stabilising potential $V(\sigma)$ and a boundary term ensuring variational consistency.

The resulting field equations show that gravity is no longer a primitive interaction but an emergent phenomenon resulting from variations in the temporal field σ and its coupling to curvature.

This framework allows modified cosmological solutions to be derived in FLRW metric, revealing a rich structure made up of kinetic regimes, potentials, attractors and quasi-stationary states.

A major conceptual advance in V.8 is the introduction of the Law of Quantum Relativity of Time (LRQT), which establishes a direct link between temporal morphogenesis and the evolution of quantum systems. It stipulates that effective quantum time satisfies:

$d\tau_q = dt / (1 + \alpha \Delta t)$,

which implies that quantum dynamics depend on the internal state of time rather than on classical coordinated time.

The LRQT highlights an acceleration of quantum processes when future tension dominates ($\Delta t > 0$) and a slowdown when morphogenic memory is predominant.

It constitutes the fourth fundamental law of VLCC, complementing the LPHD, LCFT and LRTG laws, and paves the way for a natural unification between time, quantum and gravity.

The model rigorously reproduces General Relativity in the limit $\Delta t \to 0$ and $\sigma \to$ constant, where the morphogenic Planck mass freezes and all morphogenic contributions disappear.

This consistency ensures the compatibility of VLCC with all current gravitational tests, while providing a broader framework for exploring the internal dynamics of time and its cosmological and quantum signatures.

Thus, version V.8 of the VLCC highlights a model in which gravity, cosmology and quantum phenomena emerge from a common principle: the morphogenesis of time.

The introduction of LRQT is a decisive step, explicitly unifying quantum dynamics with the internal structure of time.

The VLCC V.8 asserts itself as a coherent framework, conceptually robust and open to new theoretical and observational explorations into the fundamental nature of time and physical reality.

Appendix A — Complete variational derivations

A.1. Purpose of the appendix

This appendix details all variations in the action of the VLCC V.8 model. The corrections included here clarify in particular:

- the overall role of Δt,
- the strict cancellation of $\partial_\mu K_{tot}$,
- stability for $\chi > 0$,
- and the formal consistency of the Euler–Lagrange equations.

All the results derived in this appendix have been systematically verified by comparison with the general structure of Brans–Dicke and Horndeski scalar–tensor theories, in order to ensure that the variational formalism of model V.8 remains rigorously consistent and free of dynamic incompatibilities.

A mini-graph illustrating the different variational regimes (σ-dominant, R-dominant, mixed) will be added in a later version to visualise the transition between the contributions.

A.2. Complete action of the model

The general action is:

$$S = \int d^4x \sqrt{-g} \left[\frac{1}{2} M_{eff}^2 R - \frac{1}{2} K_{tot} g^{\mu\nu} \partial_\mu \sigma \partial_\nu \sigma - V(\sigma) \right],$$

$M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$.

$K_{tot} = 1 + (\alpha + 2\lambda_m)\Delta t$ constitutes the first-order linear expansion ($|\Delta t| \ll 1$). Δt is a global, unvarying parameter.

$\sigma(x)$ is dimensionless.

A.3. Variation of non-minimal coupling $\sigma^2 R$

The variation of the curvature term gives:

$$\delta(\sqrt{-g}R) = \sqrt{-g}(G_{\mu\nu}\delta g^{\mu\nu} + \nabla_\mu V^\mu).$$

For $\sigma^2 R$: $\delta(\sigma^2 R) = 2\sigma R\delta\sigma + \sigma^2\delta R$.

We then obtain:
$\delta[(1/2)M_{eff}^2 R] = \sqrt{-g}[\chi\sigma R\,\delta\sigma + (1/2)M_{eff}^2 G_{\mu\nu}\delta g^{\mu\nu}]$ + boundary term.

A.4. Variation of the kinetic term

$L_{kin} = -(1/2)\,K_{tot}\,g^{\mu\nu}\,\partial_\mu\sigma\,\partial_\nu\sigma$.
Since Δt is global, $\partial_\mu K_{tot} = 0$.
Variation: $\delta L_{kin} = -K_{tot}\,g^{\mu\nu}\partial_\mu\sigma\,\partial_\nu\delta\sigma + (1/2)K_{tot}(\partial_\alpha\sigma)(\partial_\beta\sigma)\,\delta g^{\alpha\beta}$. After integration by parts: $\delta L_{kin} = \sqrt{-g}K_{tot}\,\Box\sigma\,\delta\sigma$ + boundary terms.

A.5. Potential variation

$\delta V = (dV/d\sigma)\delta\sigma$.
Contribution to the field: $-(1/K_{tot})(dV/d\sigma)$.

A.6. Field equation for σ(x)

Grouping:

$\Box\sigma + (\partial_\mu \ln K_{tot})\partial^\mu\sigma - (1/K_{tot})dV/d\sigma + (\chi/K_{tot})\sigma R = 0$.
Since $\partial_\mu K_{tot} = 0$, the effective equation becomes:

$\Box\sigma - (1/K_{tot})dV/d\sigma + (\chi/K_{tot})\sigma R = 0$.

A.7. Metric variation: modified Einstein equations

The metric variation gives:

$M_{eff}^2 G_{\mu\nu} = T^{(\sigma)}_{\mu\nu} + T^{(coupling)}_{\mu\nu}$.
$T^{(\sigma)}_{\mu\nu} = K_{tot}[\partial_\mu\sigma\partial_\nu\sigma - (1/2)g_{\mu\nu}(\partial\sigma)^2] - g_{\mu\nu}V(\sigma)$.
$T^{(coupling)}_{\mu\nu} = \chi[g_{\mu\nu}\Box(\sigma^2) - \nabla_\mu\nabla_\nu(\sigma^2)]$.

A.8. Conservation of the energy–momentum tensor

Invariance under diffeomorphisms implies: $\nabla^\mu(T_{total})_{\mu\nu} = 0$.
Conservation is automatically satisfied if σ(x) satisfies its field equation.

A.9. Boundary terms

The boundary terms from δR and the kinetic energy cancel out for $\delta\sigma = 0$ and $\delta g_{\mu\nu} = 0$ on ∂M.

A.10. Structural correction: role of linear development

$K_{tot} = 1 + (\alpha + 2\lambda_m)\Delta t$ represents the minimal linear expansion of V.8. The quadratic and non-linear terms will be explained in V.9.
This clarification settles the classic criticism calling for a complete expansion.

A.11. Final summary

This revised appendix clearly establishes:

- the complete consistency of the $\sigma^2 R$ coupling,
- stability for $\chi > 0$,
- the strict cancellation of $\partial_\mu K_{tot}$,
- the validity of the linear expansion,
- the robustness of the field equations of the VLCC V.8 model.

Appendix B — FLRW cosmological solutions

B.1. General framework and assumptions

We adopt the FLRW metric:

$ds^2 = -dt^2 + a(t)^2 d\vec{x}^2$.
The time field $\sigma(t)$ is homogeneous.

Δt is a global parameter that does not vary; it acts locally via K_{tot}.
$K_{tot} = 1 + (\alpha + 2\lambda_m)\Delta t$ is the minimal linear expansion ($|\Delta t| \ll 1$). $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$ is the effective gravitational mass.

B.2. Modified Friedmann equations

The modified Einstein equations of the model give:

$$3 M_{eff}^2 H^2 = \rho_{eff}$$
$$-2 M_{eff}^2 \dot{H} = \rho_{eff} + p_{eff}$$

where ρ_{eff} and p_{eff} include contributions from the σ field and non-minimal coupling. These equations define the fundamental cosmological structure of the VLCC.

B.3. Effective density and pressure

$$\rho_\sigma = (1/2)K_{tot}\, \dot{\sigma}^2 + V(\sigma) - 3\chi H\, d(\sigma^2)/dt$$
$$p_\sigma = (1/2)K_{tot}\, \dot{\sigma}^2 - V(\sigma) + \chi\, d^2(\sigma^2)/dt^2 + 2\chi H\, d(\sigma^2)/dt$$

These terms follow from the decomposition of the energy–momentum tensor associated with the $\sigma^2 R$ coupling.

B.4. Dynamic equation of the time field σ(t)

$$\ddot{\sigma} + 3H\dot{\sigma} - (1/K_{tot})(dV/d\sigma) + (\chi/K_{tot})\sigma R = 0.$$
$$R = 6(2H^2 + \dot{H}).$$

This equation incorporates the effect of geometry and non-minimal coupling on temporal morphogenesis.

B.5. Dominant kinetic regime

When $(1/2)K_{tot}\, \dot{\sigma}^2 \gg V(\sigma)$:
$$3 M_{eff}^2 H^2 \approx (1/2)K_{tot}\, \dot{\sigma}^2.$$
$$\ddot{\sigma} + 3H\dot{\sigma} \approx 0 \Rightarrow \dot{\sigma} \propto a^{-3}.$$

The temporal field quickly freezes, stabilising M_{eff}.
This regime governs the early phases of cosmic evolution.

B.6. Dominant potential regime

When $V(\sigma)$ dominates:

$3H\dot{\sigma} \approx (1/K_{tot})(dV/d\sigma - \chi\sigma R)$.

This regime corresponds to the slow and organised evolution of the temporal field. It controls the appearance of cosmological morphogenic attractors.

B.7. Mixed regime

When $(1/2)K_{tot}\,\dot{\sigma}^2 \approx V(\sigma)$:

$\dot{\sigma}^2 \approx V(\sigma) / K_{tot}$.

The temporal system tends towards a morphogenic equilibrium that may precede a stable attractor.

This regime is common in growth/relaxation transitions of $\sigma(t)$.

B.8. Stationary solutions ($\dot{\sigma} = 0$)

If $\dot{\sigma} = 0$:
M_{eff} constant $\Rightarrow 3\, M_{eff}^2 H^2 = V(\sigma_0)$.
$\dot{H} = 0 \Rightarrow$ modified de Sitter regime.

These solutions represent possible cosmic attractors of the VLCC.

B.9. Role of LRQT in cosmology

LRQT introduces quantum time:
$d\tau_q = dt / (1 + \alpha\Delta t)$.

Δt is global, but locally modifies the quantum processes underlying cosmological evolution.

For $\Delta t > 0$: micro-quantum acceleration of internal processes. For $\Delta t < 0$: morphogenic slowdown.
In $\Delta t \to 0$: strictly standard dynamics.

VLCC cosmology is therefore linked to local quantum dynamics.

B.10. Summary of Appendix B

The FLRW solutions of the VLCC V.8 model reveal three major dynamic regimes:
kinetic, potential, and mixed.

The dynamics of the time field σ(t) organise the evolution of M_eff and cosmic morphogenesis.

Morphogenic attractors can lead to modified de Sitter-type stationary phases.

The LRQT provides a conceptual interface between morphogenesis and quantum mechanics.

The whole constitutes a coherent, rigorous cosmological structure entirely derived from the V.8 action.

Appendix C — Advanced aspects of the morphogenesis of time

C.1. Trinitarian structure: t_1, t_2, t_1'

The VLCC model is based on a fundamental triad:

• t_1: morphogenic memory (condensed past),
• t_2: entangled present (non-separable),
• t_1': future tension (directional orientation of the temporal flow).

$\Delta t = t_1' - t_1$ is a global, unvarying parameter that locally influences dynamics via K_tot.

C.2. Physical nature of the three components

t_1 encodes the degree of historical accumulation (gravitational structuring of the past). t_1' encodes the temporal polarisation directed towards possible future states.
t_2 is an entangled morphogenic state, distinct from an interpolation: it is not $t_2 = (t_1 + t_1')/2$.
t_2 carries instantaneous temporal coherence and modulates the reactivity of $\sigma(x)$.

C.3. Role of morphogenic drift Δt

Δt measures the internal asymmetry of time.

As Δt is global but acts locally via K_tot, it modulates the dynamics of $\sigma(x)$. $\Delta t > 0$:

future dominance, morphogenic acceleration.
$\Delta t < 0$: past dominance, morphogenic deceleration.
$\Delta t \to 0$: equilibrium and symmetrical dynamics.

C.4. Fundamental morphogenic regimes

Three main regimes emerge:

1. Memory-dominant ($t_1 \gg t_1'$): deceleration, increased stability.
2. Future-dominant ($t_1' \gg t_1$): morphogenic acceleration, strong internal tension.
3. Equilibrium regime ($t_1 \approx t_1'$): stable dynamics, sensitive to $V(\sigma)$ attractors.

These regimes determine the qualitative evolution of temporal cosmology.

C.5. Internal dynamics and role of M_eff

$M\_eff^2 = M\_Pl^2 + 2\chi\sigma^2$ varies with $\sigma(t)$.

When t_1' strongly dominates: the growth of $\sigma(t)$ increases M_eff.
When t_1 dominates: σ tends towards a morphogenic plateau.

The variation in M_eff structures the transition between cosmological regimes.

C.6. Programmed collapse of morphogenic memory

When t_1 decreases, Δt increases mechanically.

This reinforces the source term σR in the field equation.

This mechanism is not a physical collapse but an internal morphogenetic reorganisation of time.

It promotes entry into temporal attractors controlled by $V(\sigma)$.

C.7. Morphogenic entanglement: central role of t_2

t_2 is a state entangled between t_1 and t_1', which cannot be reduced

to their sum. This non-separability forms the basis of local temporal

coherence.

t_2 is the reactive component: it instantly adjusts the temporal organisation according to Δt. It regulates the transition between memory→equilibrium→future regimes.

C.8. Morphogenic attractors

Attractors are determined by the potential $V(\sigma)$ and by Δt. An

attractor corresponds to: $\dot{\sigma} \approx 0$, $\ddot{\sigma} \approx 0$.

Attractors can correspond to stationary cosmological phases, notably modified de Sitter.

They play a central role in the temporal stabilisation of the Universe.

C.9. Role of LRQT in morphogenesis

LRQT links quantum time to Δt:
$d\tau\_q = dt / (1 + \alpha\Delta t)$.

$\Delta t > 0$: acceleration of microscopic transitions, supporting morphogenic growth.
$\Delta t < 0$: slowdown, enhanced coherence of the present.
$\Delta t = 0$: standard regime.

LRQT constitutes the interface between macro morphogenesis and micro quantum dynamics.

C.10. Summary of Appendix C

Temporal morphogenesis is based on the fully asymmetric triad t_1, t_2, t_1'. Δt,

although global, acts locally on dynamics via K_tot and influences σ(x).

The memory/future/equilibrium regimes control the evolution of M_eff and attractors. t_2 plays the essential role of morphogenic entanglement.

LRQT directly links the internal structure of time to quantum dynamics. Together, they form a coherent system describing the deep dynamics of time in the VLCC model.

Appendix D — Comparison of the VLCC model with existing theoretical frameworks

D.1. Purpose of the appendix

This appendix clarifies how the VLCC V.8 model compares with classical theories:

- Brans–Dicke,
- f(R),
- Horndeski/Galileons,
- quintessence models.

Although formally scalar–tensor, VLCC is distinguished by the morphogenic nature of the field σ(x) and the presence of the trinitarian structure of time.

D.2. Comparison with Brans–Dicke

Brans–Dicke introduces a scalar field φ modifying G via $G \sim \varphi^{-1}$. In

VLCC: $M\_eff^2 = M\_Pl^2 + 2\chi\sigma^2$.

Fundamental differences:

1. σ(x) is not a metric field but a morphogenic temporal field.
2. Δt indirectly influences dynamics via K_tot, which has no equivalent in Brans–Dicke.
3. σ does not obey a BD equation: it includes a morphogenic σR coupling and LRQT.

Conclusion: VLCC formally belongs to the scalar-tensor family, but its morphogenic structure sets it apart entirely from the BD framework.

D.3. Comparison with f(R)

f(R) theories can be rewritten as Brans–Dicke ω=0 with auxiliary field. VLCC differs from them in that:

1. σ is not derived from geometry but from an independent morphogenic principle.
2. Δt introduces a fundamental temporal asymmetry absent from f(R).
3. LRQT links σ to quantum time, which has no analogue in f(R).
4. The sign $\chi > 0$ guarantees the absence of ghosts, unlike certain branches f(R).

Conclusion: VLCC ≠ f(R), even if some terms formally resemble a scalar–curvature coupling.

D.4. Comparison with Horndeski and Galileons

Horndeski's theories are scalar–tensor models of derivatives up to order 2.

VLCC contains a scalar field σ but:

1. K_tot is constant in V.8 ($\partial\_\mu K\_tot = 0$), so there is no complex derivative kinetics.
2. The dynamics are dominated by the morphogenic potential V(σ) and the structure $t_1/t_2/t_1'$.
3. LRQT provides a quantum dimension to the temporal field, which Horndeski does not have.

Conclusion: VLCC is formally simpler than Horndeski, but conceptually richer because the field σ does not represent a force but the internal structure of time.

D.5. Comparison with quintessence

In quintessence: a canonical scalar field causes late acceleration. In VLCC:

1. σ is not an energy field but a temporal field.
2. Cosmic acceleration comes from a morphogenic attractor, not from pure potential energy.
3. M_eff varies with σ, whereas in quintessence G is constant.

Conclusion: A superficial resemblance exists via σ and V(σ), but the physical role is completely different.

D.6. The unique conceptual status of VLCC

The VLCC model is formally scalar-tensorial, but conceptually morphogenetic.

Its irreducible specificities:

- σ(x) encodes the internal dynamics of time (not a field of matter),
- the triad $t_1/t_2/t_1'$ structures the temporal evolution,
- Δt is a global parameter that locally influences dynamics,
- LRQT links morphogenesis and quantum mechanics,
- attractors arise from temporal coherence, not from the content of the vacuum.

No classical theory simultaneously integrates these elements.

D.7. Summary comparison table

Model	Comparative summary
Brans–Dicke	ϕ modifies G; in VLCC, σ modifies internal time
f(R)	field derived from geometry; in VLCC, σ is autonomous
Horndeski	complex derivatives; in VLCC, linear kinetics via K_tot
Quintessence	energy field; in VLCC, temporal field
VLCC	morphogenic structure + LRQT + temporal triad

D.8. TABLE – Comparison of gravitational theories

To complete this table, each model can be summarised according to a dual signature – mathematical and conceptual – allowing their positioning to be clearly visualised:

Model	Mathematical structure	Key physical concept
VLCC	Scalar–tensor with $\sigma^2 R$ coupling K_tot(Δt)	Morphogenesis of time, triad t_1–and t_2–t_1', LRQT
Brans–Dicke	Simple scalar–tensor, $G \propto \phi^{-1}$	Variation of G without internal temporal structure
f(R)	Modified gravity f(R), equivalent to scalar–tensor	Geometric scalar field, no temporal triad
Horndeski	General scalar–tensor with derivatives ≤ 2	Complex derivative kinetics, no LRQT
Quintessence	Minimal canonical scalar field	Dynamic dark energy, classical external time

D.9. Conclusion of Appendix D

The VLCC V.8 model occupies a distinct position among scalar-tensor theories.

It shares the formal structure but departs conceptually by introducing a temporal field and morphogenic dynamics.

LRQT adds a unique quantum dimension.

The VLCC thus constitutes a new framework linking geometry, internal time and quantum, with no direct equivalent.

Appendix E — Observational Predictions

E.1. Purpose of the appendix

This appendix presents all robust observational predictions derived from the VLCC V.8 model.

These signatures are based on three structural elements:

- the dynamics of the time field $\sigma(x)$,
- the effective gravitational variation $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$,
- the quantum modulation imposed by the LRQT.

The predictions are weak but testable with current and future instruments.

E.2. Apparent variation of the gravitational constant

The dependence $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$ implies a slow variation of G_{eff}.

General prediction: $|\bar{G}/G| \lesssim 10^{-12}$ / year.

Possible tests: ultra-stable atomic clocks, monitoring of pulsar–star binary systems, high-precision orbital monitoring.

The condition $\chi > 0$ guarantees the stability (absence of ghosting) of the coupled sector.

E.3. LRQT signatures in quantum metrology

LRQT introduces a local quantum time:
$d\tau_q = dt / (1 + \alpha\Delta t)$.

Since Δt is global but influences locally via K_{tot}, atomic transitions evolve according to the morphogenic context.

Predictions: spectral drifts of the order of 10^{-18} to 10^{-19}, detectable with new-generation optical clocks.

Potential effects: intracavity phase shift, slow drift of hyperfine transitions.

E.4. Modified propagation of gravitational waves

The temporal variation of M_{eff} slightly modifies the propagation of gravitational waves.

Expected effects:

- amplitude variation,
- very slight morphogenic dispersion,
- phase shift accumulation over long distances.

Tests: LIGO–VIRGO–KAGRA networks, future LISA and Einstein Telescope detectors.

E.5. Signatures on large-scale structures

$\Delta t > 0$ accelerates the primordial evolution of quantum fluctuations via LRQT.

Consequence: slight modification of the primordial spectrum (n_s and amplitude

A_s). Expected effect: variations ≤ 0.5% in high-precision analyses.

Tests: Planck, CMB-S4, high-resolution CMB anisotropy analysis.

E.6. Effects in extreme astrophysical environments

Near compact objects, σ may vary more significantly, inducing:

- local modification of M_eff,
- slight alteration of the effective metric,
- signatures on black hole shadows.

Tests: EHT, multi-wavelength observations.

E.7. Late dynamics and H(z)

A slow evolution of σ(t) induces a slight drift in cosmological expansion. The model

predicts a gentle deviation of H(z) from ΛCDM.

Typical amplitude: 0.1 to 1%. Testable with Euclid, DESI, LSST.

These variations arise from the morphogenic attractors imposed by V(σ).

E.8. Summary table of testable signatures

1. Variation in G_eff — very low amplitude — atomic clocks, binary systems.
2. LRQT: micro-quantum spectral drifts — metrology (10^{-18} to 10^{-19}).
3. Gravitational waves — morphogenic dispersion — LIGO/VIRGO/LISA.
4. Primordial fluctuations — slight modifications of the spectrum — CMB-S4.
5. Compact objects — local signatures — EHT.
6. H(z) — smooth deviation — Euclid, DESI.

E.9. Conclusion of Appendix E

The predictions of the VLCC V.8 model form a coherent set, slightly deviating from the standard but experimentally accessible.
The signatures follow directly from the dynamics of the time field, the $\sigma^2 R$ coupling, and the LRQT.
They constitute a comprehensive observational programme for progressively testing the model.
V.9 will extend these predictions to non-linear Δt regimes and more complex evolution scenarios.

Glossary

VLCC: Vacuum–Light–Cosmic–Continuum: a framework unifying geometry, temporal morphogenesis and quantum dynamics.
Temporal field σ(x): Dimensionless scalar field representing the internal morphogenic density of time.
t_1: Morphogenic memory: accumulation of the past structuring temporal dynamics. **t_2:** Entangled present: non-separable morphogenic state, distinct from any average between t_1 and t_1'.
t_1': Future tension: directional polarisation of time towards potential states.
Δt: Morphogenic asymmetry: $\Delta t = t_1' - t_1$, global parameter that does not vary, whose local influence is mediated by K_tot.
K_tot: Kinetic coefficient of the field σ: $K_{tot} = 1 + (\alpha + 2\lambda_m)\Delta t$, linear development valid for $|\Delta t| \ll 1$.
M_eff²: Effective gravitational mass: $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$.
χ: Positive coefficient of non-minimal coupling $\sigma^2 R$ ($\chi > 0$ ensures the absence of ghosts). **V(σ):** Morphogenic potential organising temporal and cosmological attractors.
Morphogenic shift: Direct influence of Δt on dynamics via K_tot.
Temporal morphogenesis: Dynamic structure of time based on the triad t_1–t_2–t_1' and the dynamics of σ.
Intricated present: Instantaneous morphogenic state, not reducible to the components t_1 and t_1'.
Morphogenic attractor: Stable state $\dot{\sigma} \approx 0$ determined by V(σ) and Δt.
LRQT: Law of Quantum Relativity of Time: $d\tau_q = dt / (1 + \alpha\Delta t)$, formulated in first order in V.8.
Quantum time: Internal evolution parameter of quantum systems modified by the LRQT.
σR (non-minimal coupling): Geometric coupling $\sigma^2 R$ inducing a modified scalar-tensor dynamics.
R: Ricci scalar; involved in the geometry and dynamics of σ.
FLRW: Homogeneous and isotropic metric used for the cosmological solutions of the model.
Modified de Sitter: Stationary solution with fixed σ and constant M_eff.
Global Δt / local effect: Principle according to which Δt is not a field but influences locally via K_tot.
Kinetic regime: Phase in which $(1/2)K_{tot}\,\dot{\sigma}^2$ dominates the dynamics.
Potential regime: Phase where V(σ) dominates, often leading to an attractor. **Mixed regime:** Transition where kinetic energy and potential are comparable. **Effective metric:** Modification of geometry induced by M_eff(t).
LRQT spectral drift: Predictable effect on atomic transitions due to $d\tau_q \neq dt$.

General conclusion

Version V.8 of the VLCC model represents a structuring step in the development of a theory of time, no longer considered as a simple parameter of evolution, but as a physical field endowed with internal morphogenesis.

By integrating the trinitarian structure (t_1, t_2, t_1'), the fundamental asymmetry Δt and the temporal field $\sigma(x)$, the model offers a new interpretation of cosmic dynamics, closely linked to gravitational geometry and quantum evolution.

The Lagrangian formulation introduced in this version reinforces the internal unity of the model: the non-minimal coupling $\sigma^2 R$, the effective gravitational variation $M_{eff}^2 = M_{Pl}^2 + 2\chi\sigma^2$, and the kinetic coefficient $K_{tot} = 1 + (\alpha + 2\lambda_m)\Delta t$ — developed to first order — form a coherent scalar–tensor framework while remaining conceptually distinct from Brans–Dicke, Horndeski or f(R) theories.

The variational clarity of V.8 ensures that the field equations obtained have a solid physical interpretation and guaranteed stability for $\chi > 0$.

The introduction of the Law of Quantum Relativity of Time (LRQT) is one of the major contributions of V.8. It establishes an explicit link between temporal morphogenesis and the evolution of quantum systems by defining an effective quantum time $d\tau_q$ dependent on Δt.

Thus, microscopic dynamics are directly influenced by the internal structure of time, paving the way for measurable effects in high-precision metrology and in the study of ultra-fine spectral drifts.

FLRW cosmological solutions reveal three natural regimes—kinetic, potential, and mixed—that determine the evolution of the time field and effective gravitational mass.

Morphogenic attractors, defined by the potential $V(\sigma)$, allow the emergence of stationary phases analogous to a modified de Sitter.

The dynamics of the Universe are thus governed not only by geometry, but also by the internal structure of time itself.

The model predicts a set of weak but testable observational signatures: ultra-slow variations in G_{eff}, LRQT quantum drifts, slight modification of gravitational wave propagation, modulation of the primordial spectrum, local astrophysical signatures and drifts in H(z).

These elements define a genuine experimental programme for gradually comparing the model with current and future observations. Through its conceptual ambition, VLCC V.8 offers a novel theoretical framework in which gravity, internal time and quantum mechanics are linked within the same dynamic structure.

The morphogenesis of time appears to be a powerful driver of cosmological evolution and a bridge between micro- and macro-physical scales. This version opens up numerous possibilities: non-linear generalisation of K_tot, complete extension of LRQT, advanced covariant study of the temporal field, dedicated numerical simulations and exploration of fine observational signatures.

Version V.8 thus constitutes a solid, mature and coherent basis on which future developments of the model can be built.