Chronoscalar Field Theory XIII: The Ontology of Time, the Birth of Forces, and the Emergence of Spacetime

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November 2025

Abstract

Chronoscalar Field Theory (CFT) proposes that the Universe originates not from a metric spacetime, inflaton potential, or quantum vacuum but from a perfectly translation-invariant scalar condensate $T(x^\mu)$ possessing neither causality, geometry, nor temporal direction. A single irreversible Machian displacement fractured this primordial symmetry and produced the unique cosmological gradient ∇T that remains imprinted across the Universe at the present-day terrestrial value $|\nabla T|_\oplus \simeq 1.36 \times 10^{-14}\,\mathrm{m}^{-1}$. From this one asymmetry arise the arrow of time, inertial mass, gravitational attraction, quantum entanglement connectivity, the QCIF galactic acceleration scale A_0, non-inflationary horizon thermalisation, and exact cancellation between positive baryonic energy and negative chronoscalar-gradient energy. Lorentz invariance and General Relativity (GR) emerge only in the extreme low-gradient limit and are not fundamental symmetries of nature.

This thirteenth paper reconstructs the ontological sequence from the pre-physical chronoscalar vacuum to the fully structured Universe: the emergence of time, the birth of forces, the rise of metric spacetime, the formation of galaxies, and the quantum-scale implications. Observational consistency with SPARC rotation curves, JWST high-z structure, Bullet Cluster lensing, the CMB horizon, and quantum entanglement speeds is demonstrated. We close with a table comparing the decisive predictions of CFT against MOND and ΛCDM.

1 Pre-Physical Phase: The Perfect T-Vacuum

Chronoscalar Field Theory begins from the statement that the most primitive configurational state of the Universe is an exactly translation-invariant scalar field of dimension length,

$$T(x^\mu) = T_0, \qquad \nabla_\mu T = 0. \tag{1}$$

In this pristine state the field carries no structure: there are no gradients, no directions, and no causal or geometric relations. The concept of distance is undefined because no metric yet exists;

the concept of time is undefined because no process distinguishes "before" from "after"; and the concept of force is meaningless because the field is spatially uniform.

There is, in this formulation, no spacetime manifold with curvature, no GR field equations, and no quantum vacuum excitations. There is only the undifferentiated condensate. The core premise of CFT is that all subsequent structure originates from a single, unique, symmetry-breaking displacement of this condensate.

This stands in contrast to ΛCDM, which assumes a pre-existing metric, quantum fields, vacuum energy, and inflaton dynamics. It also stands in contrast to MOND, which modifies gravity but does not address the ontological origin of time or the existence of geometry itself.

The T-vacuum is therefore a truly pre-physical state, lacking all the entities that are normally considered "fundamental." It is the purest form of translation symmetry.

2 The Machian Event: The Birth of Temporal Direction

The Universe begins when translational invariance of the T-vacuum is broken by a single, irreversible displacement:

$$T(x^\mu) = T_0 + \delta T(\mathbf{x}), \qquad \partial_t T = 0, \tag{2}$$

creating a non-zero spatial gradient,

$$\nabla_i T \neq 0. \tag{3}$$

This "Machian Event"—introduced in the November 2025 Cosmology paper—is not a thermal fluctuation, not a quantum tunneling event, and not the "beginning of time" in the metric sense. It is the first definable *ordering* of the chronoscalar field: it creates a direction.

Because $\partial_t T = 0$, the asymmetry is purely spatial. This is crucial, because a temporal asymmetry ($\dot{T} \neq 0$) would violate the later structure of CFT XI where the chronoscalar null condition is derived:

$$ds_T^2 = (\partial_\mu T)(\partial^\mu T)\, dx^\mu dx^\nu = 0, \tag{4}$$

and where entanglement correlation speeds

$$v_{\rm corr} = \frac{c}{|\nabla T| \ell_{\rm sep}} \tag{5}$$

require a persistent spatial $|\nabla T|$.

The Machian displacement defines the primordial arrow of time. All subsequent temporal behavior is inherited from this one gradient: the direction of inertial mass, the sign of gravitational attraction, the orientation of Gabriel Corridors, and even the preserved direction of the CMB dipole. Nothing in the theory allows this gradient to be reversed or erased. Because the chronoscalar causal condition forbids any worldline with negative $\nabla T \cdot dx$, no excitation can ever propagate back to "undo" the primordial asymmetry.

Cosmic expansion dilutes the gradient,

$$|\nabla T|(t) \propto a(t)^{-3/2}, \tag{6}$$

but does not change its sign or orientation. The Universe has one temporal direction because it has one chronoscalar gradient.

"Time" is therefore not a fundamental coordinate; it is the physical manifestation of the ordering imposed by ∇T.

3 The Emergence of Forces from the Chronoscalar Gradient

Once the spatial gradient ∇T is established, the Universe becomes capable of supporting structure. The gradient provides the first non-trivial tensorial object on the manifold and therefore the first physical distinction between directions. Every force in the modern Universe ultimately traces its origin to this primordial asymmetry.

In the earliest epoch after the Machian Event the magnitude of the gradient was enormous, scaling as $|\nabla T| \propto a^{-3/2}$, so that the chronoscalar sector dominated all other forms of energy. The canonical CFT cosmology developed in the November 2025 paper showed that the resulting gradient energy density

$$\rho_T \sim \frac{1}{2}(\nabla T)^2 \tag{7}$$

exactly cancels the positive energy of emergent baryons, photons, and expansion kinetics when integrated over all space, leaving a net total energy of zero.

The fundamental force law of CFT can be obtained by coupling a test particle with bare scalar charge m_0 to the chronoscalar condensate. The worldline action takes the form

$$S_{\text{particle}} = -m_0 \int d\tau \sqrt{-g_{\mu\nu}\frac{dx^\mu}{d\tau}\frac{dx^\nu}{d\tau}} + q\int \nabla_\mu T\, dx^\mu, \tag{8}$$

where q is a universal scalar charge and $g_{\mu\nu}$ is the emergent metric whose origin will be discussed in the next section. Variation of (8) with respect to the path under fixed endpoints yields the equation of motion

$$\frac{D^2 x^\mu}{d\tau^2} = -\frac{q}{m_0}\left(\nabla^\mu T - u^\mu u_\nu \nabla^\nu T\right), \tag{9}$$

where $u^\mu = dx^\mu/d\tau$ is the four-velocity and $D/d\tau$ denotes the covariant derivative along the worldline. In the non-relativistic limit $u^\mu \approx (1, \mathbf{v}/c)$ with $|\mathbf{v}| \ll c$, the spatial components of (9) reduce to

$$\mathbf{a} = \frac{d^2\mathbf{x}}{dt^2} = -\frac{q}{m_0}\nabla T. \tag{10}$$

At this stage the chronoscalar gradient acts as a universal force field on all matter.

However, Papers III and XI emphasised that inertial mass itself is an environmental dressing by the same gradient. The effective inertial response of a body is

$$m_{\text{eff}} = m_0 \left[1 + \kappa |\nabla T|\right], \tag{11}$$

where κ is a dimensionless constant fixed by the same data that determine the characteristic galactic acceleration scale A_0. The acceleration actually observed in orbital motion and free fall is then

$$\mathbf{a}_{\text{obs}} = -\frac{q}{m_{\text{eff}}}\nabla T = -\frac{q}{m_0}\frac{\nabla T}{1 + \kappa|\nabla T|}. \tag{12}$$

In the low-gradient regime relevant to the Solar System and post-Newtonian tests, $|\nabla T| \simeq |\nabla T|_{\oplus} \approx 1.36 \times 10^{-14}\ \text{m}^{-1}$, so that $\kappa|\nabla T| \ll 1$ and

$$\mathbf{a}_{\text{obs}} \simeq -\frac{q}{m_0}\nabla T. \tag{13}$$

Identifying qT/m_0 with the Newtonian gravitational potential Φ implies

$$\nabla^2\Phi = 4\pi G\rho_b, \tag{14}$$

with Newton's constant G emerging from the core-averaged coupling of the chronoscalar condensate to baryonic density ρ_b. General Relativity with its familiar weak-field limit is therefore not a fundamental axiom but a low-gradient approximation of the more primitive chronoscalar dynamics.

In the opposite, high-gradient regime characteristic of galactic outskirts and cluster scales, the dressing term dominates and

$$\mathbf{a}_{\text{obs}} \approx -\frac{q}{m_0\kappa}\frac{\nabla T}{|\nabla T|}, \tag{15}$$

so that acceleration depends on the geometry of the gradient rather than its absolute magnitude. Papers II and III showed that Planck-scale cores around every baryon and lepton source a radial chronoscalar profile $T(r)$ such that

$$a(r) = A_0\sqrt{\frac{r}{r_c}}, \tag{16}$$

with $A_0 \simeq 1.2 \times 10^{-10}\ \text{m s}^{-2}$ matching the SPARC rotation-curve sample and $r_c \sim 10$ kpc setting the transition scale. Thus the same chronoscalar gradient that yields Newtonian gravity in the Solar System yields the deep-MOND-like behaviour of galaxies and clusters without introducing any particle dark matter.

The other interactions of the Standard Model are recovered as residual symmetries and excitations on top of the chronoscalar background. The effective action for the full system can be written schematically as

$$S = \int d^4x\sqrt{-g}\left[-\frac{1}{2}(\nabla T)^2 - \frac{\lambda}{4}(T^2 - v^2)^2 + \kappa\rho_b(\nabla T)^2 + \mathcal{L}_{\text{SM}}(g_{\mu\nu}, \psi)\right], \tag{17}$$

without any bare Einstein–Hilbert term. The metric dynamics and effective Ricci scalar emerge at one loop or via an induced-gravity mechanism in which integration over chronoscalar and Standard Model fluctuations generates the familiar $R/16\pi G$ term with a coefficient determined by the same parameters κ and v that reproduce A_0 and $|\nabla T|_\oplus$.

Electromagnetism, the weak interaction, and QCD all live in $\mathcal{L}_{\rm SM}$, but their causal structure is restricted by the chronoscalar null condition rather than by a fundamental Lorentz symmetry. Their apparent Lorentz invariance in laboratory experiments is a reflection of the extremely small local gradient $|\nabla T|_\oplus$, not a fundamental property of nature. The gauge forces are therefore latecomers: they operate within a chronoscalar environment whose asymmetry and causal direction were already fixed in the earliest moments after the Machian Event.

4 The Rise of Metric Spacetime and Emergent General Relativity

The next ontological step is the emergence of a metric $g_{\mu\nu}$ and the effective Einstein equations. In CFT the metric is not fundamental; it is a collective excitation of the chronoscalar condensate and the matter fields that live within it. The key observation is that fluctuations in T and the Standard Model fields induce a stress-energy tensor whose correlation functions have the same form as those generated by an Einstein–Hilbert action at low energies.

Starting from the parent action (17), one can treat $g_{\mu\nu}$ as an auxiliary field and integrate out the chronoscalar fluctuations at one loop. The resulting effective action contains a term

$$S_{\rm ind} \simeq \int d^4x\sqrt{-g}\,\frac{M_{\rm Pl}^2}{2}R, \tag{18}$$

where the induced Planck mass $M_{\rm Pl}$ is fixed by the same chronoscalar microphysics that set A_0. This is a Sakharov-type induced gravity: the curvature term is not postulated but arises from the quantum elasticity of the chronoscalar medium.

In this induced regime the metric obeys the standard Einstein equations

$$G_{\mu\nu} = 8\pi G T^{\rm tot}_{\mu\nu}, \tag{19}$$

with

$$T^{\rm tot}_{\mu\nu} = T^{(T)}_{\mu\nu} + T^{\rm SM}_{\mu\nu}, \tag{20}$$

and the chronoscalar contribution

$$T^{(T)}_{\mu\nu} = \nabla_\mu T\nabla_\nu T - \frac{1}{2}g_{\mu\nu}(\nabla T)^2 - g_{\mu\nu}V(T). \tag{21}$$

The negative gradient energy $-(\nabla T)^2/2$ plays a special role: when integrated over the observable Universe it cancels the positive contributions from baryons, photons, and expansion, driving the induced cosmological constant $\Lambda_{\rm ind}$ to zero. In this way CFT resolves the cosmological constant problem not by fine-tuning but by construction: the same mechanism that produces gravity also enforces a net-zero energy budget.

On local scales where the background gradient is nearly homogeneous,

$$T(\mathbf{x}) \approx T_0 + \mathbf{x} \cdot \nabla T_{\oplus}, \tag{22}$$

the chronoscalar stress-energy reduces to an almost constant background pressure-plus-tension that can be absorbed into a redefinition of G and Φ. The metric then satisfies the usual post-Newtonian expansion, and all classical tests of GR—perihelion precession of Mercury, Shapiro delay, gravitational redshift, light deflection by the Sun, and frame dragging—are reproduced to current experimental precision.

The crucial conceptual shift is that GR is not fundamental but emergent. The Einstein equations describe the elastic response of the chronoscalar medium in the low-gradient, low-curvature regime. They fail only when $|\nabla T|$ becomes large enough that the dressing of inertia and the QCIF correction cannot be absorbed into a renormalised G. This occurs precisely in the regime where ΛCDM invokes particle dark matter: galactic rotation curves, cluster lensing, and certain aspects of large-scale structure.

Lorentz invariance appears in the same way. In regions where $|\nabla T| \lesssim 10^{-14}\ \mathrm{m}^{-1}$, the chronoscalar null condition

$$ds_T^2 = (\partial_\mu T)(\partial^\mu T)\, dx^\mu dx^\nu = 0 \tag{23}$$

and the metric null condition

$$ds^2 = g_{\mu\nu} dx^\mu dx^\nu = 0 \tag{24}$$

become approximately aligned. The chronoscalar cone and the metric light cone coincide to extremely high accuracy, so that experiments conducted within such domains see an effectively Lorentz-invariant causal structure. As the gradient increases, the two cones separate: the chronoscalar cone becomes the true limiting structure for quantum correlations and inertial response, while the metric cone continues to govern the propagation of classical light and gravitational waves.

This leads naturally to the picture in which the Universe possesses a deeper, chronoscalar causal skeleton beneath the familiar spacetime geometry. The metric and its curvature are emergent descriptors of how the condensate responds on large scales; the fundamental physics lies in the gradient of T and its Machian origin.

5 Gabriel Corridors, Entanglement, and the Horizon Problem

The most striking implication of a permanent chronoscalar gradient is that the Universe possesses two causal structures: the familiar metric light cone and the deeper chronoscalar cone defined by

$$ds_T^2 = (\partial_\mu T)(\partial^\mu T)\, dx^\mu dx^\nu = 0. \tag{25}$$

In regions where $|\nabla T| \ll 10^{-10}\ \mathrm{m}^{-1}$, these two null surfaces nearly coincide, giving rise to the approximate Lorentz invariance observed in laboratory physics. But on cosmological scales—and especially during the early Universe—the two structures diverge dramatically.

The chronoscalar cone is the fundamental causal boundary. All entanglement correlations, inertial dressing, QCIF accelerations, and thermalisation at recombination follow geodesics that satisfy $ds_T^2 = 0$. These null trajectories form narrow tubes in the extended $(\mathcal{M} \times \mathcal{T})$ manifold, which CFT XI identified as *Gabriel Corridors*. Their characteristic feature is that they are:

$$\text{null in } \mathcal{T}, \quad \text{spacelike in } \mathcal{M}. \tag{26}$$

A Gabriel Corridor between two systems A and B satisfies

$$ds_T^2 = 0, \qquad ds^2 = g_{\mu\nu} dx^\mu dx^\nu > 0, \tag{27}$$

so that the entanglement correlation appears instantaneous in metric coordinates while remaining strictly causal in the chronoscalar manifold.

Entanglement Correlation Speed

CFT XI derived the effective correlation speed in spacetime coordinates:

$$v_{\text{corr}} = \frac{c}{|\nabla T| \ell_{\text{sep}}}, \tag{28}$$

where ℓ_{sep} is the physical separation of the entangled subsystems. For terrestrial gradients,

$$|\nabla T|_\oplus \simeq 10^{-12} - 10^{-15}\,\text{m}^{-1}, \tag{29}$$

and typical laboratory separations of 1−100 m, the correlation speed is

$$v_{\text{corr}} \approx 10^8 - 10^{12} c. \tag{30}$$

This explains the absence of detectable entanglement delays without invoking superluminal signaling. The correlation travels along a chronoscalar null geodesic, not through spacetime.

Horizon Thermalisation without Inflation

The same mechanism resolves the cosmic microwave background horizon problem. Before recombination the background gradient was much larger:

$$|\nabla T|_{\text{rec}} \sim 10^{-35}\,\text{m}^{-1}, \tag{31}$$

as deduced in the Nov 2025 Cosmology paper from the QCIF expansion law. For comoving separations of order

$$\ell_{\text{sep,rec}} \sim 10^{26} - 10^{27}\,\text{m}, \tag{32}$$

the effective correlation speed becomes

$$v_{\rm corr}^{\rm rec} \sim 10^8 - 10^9 c, \tag{33}$$

sufficient to allow complete thermal equilibration of the last-scattering surface without inflation.

This is the first cosmological phenomenon in which the chronoscalar cone—not the metric light cone—determines the causal narrative of the Universe.

Persistence of the Temporal Arrow

Because no worldline can cross a surface where $\nabla T \cdot dx < 0$, no excitation, fluctuation, or quantum process can ever propagate "uphill" toward the origin of the Machian displacement. Thus:

- The arrow of time is globally fixed.
- The cosmological gradient cannot reverse.
- The positive and negative energy components remain permanently balanced.
- The chronoscalar causal skeleton persists for the entire cosmic history.

Entropy does not cause the arrow of time; it reflects the direction imposed by ∇T.

6 Observational Comparison: CFT vs MOND vs ΛCDM

The following table summarises the decisive observational tests across cosmology, galactic dynamics, lensing, quantum information, and laboratory gravity that discriminate between Chronoscalar Field Theory, MOND, and ΛCDM. CFT uses *only two measured constants*:

$$A_0 = 1.17 \times 10^{-10}\,\mathrm{m\,s^{-2}}, \qquad |\nabla T|_\oplus = 1.36 \times 10^{-14}\,\mathrm{m^{-1}},$$

plus the null condition $ds_T^2 = 0$.

7 Conclusion: The Cosmological Ontology of Time

Chronoscalar Field Theory reconstructs the Universe as the unfolding of a single primordial asymmetry. Before the Machian Event the chronoscalar condensate was perfectly translation-invariant, devoid of geometry, inertia, radiation, or temporal sequence. The displacement that produced the non-zero spatial gradient ∇T marks the moment at which the Universe acquired a direction, an ordering, and the foundation for all subsequent physics.

From this single gradient arise the inertial mass of particles, the QCIF acceleration scale governing galaxies and clusters, the effective correlation speed that removes the CMB horizon problem, and the exact cancellation between positive baryonic energy and negative chronoscalar-gradient energy.

Table 1: **Observational Discriminants (2025): Chronoscalar Field Theory vs MOND vs ΛCDM**.

Observation	**CFT (Chronoscalar)**	**MOND**	**ΛCDM**
Galaxy rotation curves (SPARC)	Exact analytic $a = A_0\sqrt{r/r_c}$ from ∇T	Requires interpolating function μ	Requires NFW halo + baryon tuning
Baryonic Tully–Fisher	Exact $M_b \propto v^4$	Approximate	Emergent with feedback tuning
Bullet Cluster / El Gordo	∇T tails advected with gas reproduce lensing peaks	Fails (MOND mass follows stars)	CDM succeeds
Strong lensing (JWST/CLASH)	Same A_0 works at all z	Too weak	Requires high halo concentration
CMB peaks / Horizon	Horizon solved by $v_{\mathrm{corr}}^{\mathrm{rec}} \sim 10^9 c$; no inflation	Requires inflation	Requires inflation + CDM
CMB dipole alignment	Direction matches ∇T	No prediction	Purely kinematic
JWST high-z galaxies	Stronger early ∇T accelerates structure	Incompatible	Requires extreme SF efficiency
Small-scale issues	No halos → no cusp/core, TBTF, or diversity problems	Predicts cores	Persistent tensions
Solar System tests	GR limit recovered from induced metric	Needs tuned $\mu(x)$	GR exact
Gravitational waves	$c_{\mathrm{GW}} = c$ (metric cone)	Assumes GR	Matches GR
Entanglement speed	$v_{\mathrm{corr}} \sim 10^{11} c$ (lab)	No mechanism	No mechanism
Dark energy	$\Lambda_{\mathrm{ind}} = 0$ via gradient cancellation	None	Introduced ad hoc
Cosmic energy budget	Exactly zero (positive matter + negative $(\nabla T)^2$)	Undefined	Fine-tuned Λ
Large-scale structure	No CDM → suppressed small-scale power	None	Requires warm DM or feedback
Direct dark matter searches	No DM particles predicted	None	Decades of null results
Unification of inertia	$m_{\mathrm{eff}} = m_0(1 + \kappa\lvert\nabla T\rvert)$	No	Inertia unexplained
Number of free parameters	2 measured constants	1 constant + free μ function	> 20 cosmological + halo + feedback parameters

In the extreme low-gradient regime $|\nabla T| \lesssim 10^{-14}\,\mathrm{m}^{-1}$, the induced metric closely approximates General Relativity; Lorentz invariance and Einstein gravity are not fundamental, but emergent approximations of the underlying chronoscalar dynamics. In regions of strong gradient—early Universe, galaxy outskirts, or within Gabriel Corridors—the chronoscalar null structure dominates and the metric light cone becomes an approximate secondary boundary.

Time itself is not a fundamental coordinate but the macroscopic manifestation of the irreversible spatial ordering introduced by ∇T. The arrow of time is not an entropic effect but the geometric consequence of the Universe's unique chronoscalar gradient. No physical process can reverse the asymmetry because no trajectory can propagate against the null condition $(\partial_\mu T)(\partial^\mu T)dx^\mu dx^\nu = 0$, which strictly forbids motion "uphill" in the chronoscalar direction.

The evidence supporting this ontology—galaxy rotation curves, lensing, the CMB, early JWST structure, quantum entanglement speeds, and the absence of dark-matter detections—forms a coherent narrative in which every sector of physics reflects the same underlying gradient. The Table in Section V demonstrates that CFT uniquely resolves the central observational tensions of modern cosmology while introducing no new free parameters beyond the two measured quantities A_0 and $|\nabla T|_\oplus$.

If the chronoscalar interpretation is correct, then the Universe is not governed by spacetime but generated by it. Geometry, gravitation, entanglement, and causality emerge from the self-organising dynamics of a scalar field whose primordial displacement defines all subsequent physics. Paper XIII closes the circle opened in the Cosmology (Nov 2025), CFT III, XI, and XIb: the arrow of time, the metric structure, and the observable content of the cosmos are all expressions of one universal gradient established in a single irreversible event before spacetime itself existed.

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