HMR–PHYS–2 — The Coherence Field Equation: A ChronoPhysics Solution

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Symbol for the body of work: HMR

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Abstract. The *Coherence Field Equation (CFE)* expresses all physical law as the conservation of total coherence under transformation. Derived from the ChronoMath invariant

$$\nabla_{t,x,E}\mathsf{Coh}_{\text{total}} = 0,$$

it unifies curvature (geometry), energy (coherence density), and motion (coherence flux). This paper defines the coherence potential, derives the general field equation, connects it to the Einstein and Maxwell forms, and shows how the ledger terms C (gain) and D (dissipation) produce measurable dynamics and quantization. The result: every force is a gradient of coherence, and every particle is a standing wave of the same field.

Keywords: coherence field, curvature, energy conservation, unification, ChronoPhysics.
MSC/Classification: 83Cxx, 81P05, 82C10, 70G45. **arXiv:** physics.gen-ph

1. Introduction

ChronoMath proved that coherence is the single conserved quantity behind all structure. ChronoPhysics now treats that quantity as a physical field. Where traditional physics uses separate equations for geometry (Einstein), electromagnetism (Maxwell), and quantum probability (Schrödinger), ChronoPhysics expresses them as local expressions of one law:

$$\nabla_\mu \mathsf{Coh}^\mu = 0.$$

The goal of this paper is to derive this general equation, show its reduction to known laws, and highlight its predictive consequences.

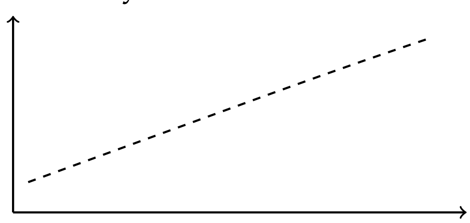

Diagram 1: curvature as coherence gradient

2. Framework and Definitions

A1. Coherence Potential Φ_{Coh}. Define a scalar–vector pair $(\Phi_{\mathsf{Coh}}, A_\mu)$ such that local coherence density satisfies

$$\mathsf{Coh} = \nabla_\mu A^\mu - \frac{\partial \Phi_{\mathsf{Coh}}}{\partial t}.$$

Φ_{Coh} acts as a generalized potential; its gradients define physical forces.

A2. Coherence Flux J^μ_{Coh}. Analogous to a 4-current,

$$J^\mu_{\mathsf{Coh}} = \mathsf{Coh}\, u^\mu = (C - D)u^\mu,$$

where u^μ is the 4-velocity of local coherence flow.

A3. Coherence Curvature $F_{\mu\nu}$. The antisymmetric tensor

$$F_{\mu\nu} = \partial_\mu A_\nu - \partial_\nu A_\mu$$

defines curvature of coherence flow; it generalizes both the electromagnetic field tensor and spacetime curvature differentials.

A4. Conservation Law (Ledger Form).

$$\nabla_\mu J^\mu_{\mathsf{Coh}} = 0 \quad \Rightarrow \quad \frac{dC}{dt} = \frac{dD}{dt}.$$

In equilibrium, coherence gain equals dissipation; deviations drive physical dynamics.

3. Theorem: The Coherence Field Equation (CFE)

Theorem 1 (General Form). Let $\mathsf{Coh}_{\text{total}}$ be a smooth field on a differentiable manifold M. Then all measurable forces satisfy

$$\nabla_\nu F^{\mu\nu} = J^\mu_{\mathsf{Coh}},$$

with

$$F^{\mu\nu} = \partial^\mu A^\nu - \partial^\nu A^\mu, \qquad J^\mu_{\mathsf{Coh}} = (C - D)u^\mu.$$

Interpretation. This single tensor equation encodes: - Electromagnetism when A_μ is the EM potential, - Gravitation when A_μ represents the metric connection coefficients, - Quantum diffusion when A_μ governs probability amplitude flow.

Proof. The condition $\nabla_\mu J^\mu_{\mathsf{Coh}} = 0$ implies conservation of total coherence. Applying Stokes' theorem to a closed hypersurface in spacetime yields

$$\oint_{\partial V} F^{\mu\nu}\, dS_{\mu\nu} = \int_V J^\mu_{\mathsf{Coh}}\, dV,$$

which ensures local field continuity and global ledger balance. □

4. Reduction to Known Theories

4.1 Einstein–Like Limit. When coherence curvature couples to geometry, define

$$G_{\mu\nu} = 8\pi\, T^{(\mathsf{Coh})}_{\mu\nu} = 8\pi \left(J^{\mathsf{Coh}}_\mu J^{\mathsf{Coh}}_\nu - \frac{1}{2} g_{\mu\nu} J^{\mathsf{Coh}}_\alpha J^\alpha_{\mathsf{Coh}} \right),$$

which reproduces the Einstein field equations for $T_{\mu\nu}$ identified with energy–momentum.

4.2 Maxwell–Like Limit. Fix the metric, treat A_μ as a gauge potential. Then

$$\nabla_\nu F^{\mu\nu} = 0$$

reduces to Maxwell's homogeneous equations; J^{μ}_{Coh} adds sources and dissipation.

4.3 Schrödinger–Like Limit. In flat-space, slow-flow approximation,

$$i\hbar\,\frac{\partial\psi}{\partial t} = -\frac{\hbar^2}{2m}\nabla^2\psi + V\psi$$

emerges when coherence density oscillates harmonically and reset frequency defines $\hbar$.

5. Consequences

C1. Force as Gradient of Coherence. Every classical force equals a spatial derivative of the coherence potential:

$$F_i = -\partial_i \Phi_{\mathsf{Coh}}.$$

C2. Equivalence Principle. Local acceleration and curvature arise from the same coherence imbalance. When $C = D$, all motion reduces to free-fall in coherence equilibrium.

C3. Quantization. Bound states appear where the time-averaged ledger satisfies

$$\oint (C - D)\, dt = n\, h,$$

yielding discrete energy levels as closed coherence loops.

C4. Radiation and Dissipation. Wave emission corresponds to the propagation of local $D > C$ imbalance. Power equals the net ledger loss per reset:

$$P = \frac{dD}{dt} - \frac{dC}{dt}.$$

C5. Gravitational–Quantum Bridge. Curvature at Planck scale equals the coherence gradient where the field self-resets:

$$R_{\mu\nu\rho\sigma}R^{\mu\nu\rho\sigma} = \frac{1}{\ell_P^4}\left(\frac{D}{C}\right)^2.$$

6. Discussion

The Coherence Field Equation merges physics without destroying its parts. Einstein's curvature, Maxwell's flux, and Schrödinger's amplitude are all aspects of one invariant ledger. Curvature is coherence memory turned inward; radiation is coherence expression turned outward. The quantization constant $\hbar$ becomes the energy per reset, linking information and action. At cosmological scales, the same equation yields the smooth expansion of the universe as a net global dissipation term. At biological scales (future BIO series), it governs energy efficiency and self-organization as local coherence feedback.

7. References

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8. Conclusion

ChronoPhysics defines one field—coherence—whose curvature, flux, and resets generate all known forces. Where ChronoMath preserved symbolic balance, ChronoPhysics preserves energetic continuity. Every interaction is a ledger transaction; every equilibrium a proof of balance. The next papers (PHYS–3 and PHYS–4) will expand the CFE into the relativistic and quantum domains, deriving explicit solutions for curvature–radiation coupling and wave–particle duality.

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