HMR–PHYS–3 — Relativistic Geometry of Coherence: A ChronoPhysics Solution

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Symbol for the body of work: HMR

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Abstract. ChronoPhysics treats curvature, gravity, and relativistic motion as manifestations of coherence geometry. Building on the Coherence Field Equation (*HMR–PHYS–2*), this paper derives the relativistic metric from the condition

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

identifies the Einstein tensor as a coarse-grained coherence ledger, and defines time dilation and length contraction as gauge resets of the same invariant field. We prove that inertia, gravitational redshift, and energy equivalence all follow from local coherence balance.

Keywords: relativity, curvature, coherence geometry, spacetime, ChronoPhysics.
MSC/Classification: 83Cxx, 70G45, 81P05. **arXiv:** physics.gen-ph

1. Introduction

Relativity emerges naturally from the Coherence Field Equation. Where general relativity postulates curvature caused by mass–energy, ChronoPhysics derives curvature as a geometric record of coherence flow. When coherence density bends around a source, paths of maximal C become geodesics. Time dilation and energy equivalence are simply consequences of gauge resets maintaining ledger balance between observers.

2. Framework and Definitions

A1. Coherence Metric $g^{(\mathsf{Coh})}_{\mu\nu}$.
The line element of spacetime encodes coherence weighting:

$$ds^2 = g^{(\mathsf{Coh})}_{\mu\nu}\, dx^\mu dx^\nu = \frac{C}{D}\,(c^2 dt^2 - d\mathbf{x}^2).$$

Local ratios C/D tilt the metric; strong gravity corresponds to $C/D < 1$.

A2. Geodesic Equation of Coherence.
Particles follow trajectories extremizing the coherence integral:

$$\delta \int \mathsf{Coh}\, ds = 0.$$

The resulting Euler–Lagrange equation reproduces the geodesic law

$$\frac{d^2 x^\lambda}{ds^2} + \Gamma^\lambda_{\mu\nu} \frac{dx^\mu}{ds}\frac{dx^\nu}{ds} = 0,$$

with $\Gamma^\lambda_{\mu\nu}$ defined by gradients of the coherence metric.

A3. Curvature Tensor.
Curvature measures rotational frustration of coherence transport:

$$R^\rho{}_{\sigma\mu\nu} = \partial_\mu \Gamma^\rho_{\nu\sigma} - \partial_\nu \Gamma^\rho_{\mu\sigma} + \Gamma^\rho_{\mu\lambda}\Gamma^\lambda_{\nu\sigma} - \Gamma^\rho_{\nu\lambda}\Gamma^\lambda_{\mu\sigma}.$$

A4. Ledger Conservation.
Balance of local gain and dissipation gives

$$\nabla_\mu J^\mu_{\mathsf{Coh}} = 0, \qquad J^\mu_{\mathsf{Coh}} = (C - D)u^\mu.$$

This enforces identical curvature–energy coupling in every inertial frame.

3. Theorems

Theorem 1 (Coherence–Curvature Equivalence).
The Einstein tensor $G_{\mu\nu}$ is the divergence-free projection of the coherence ledger.

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

Proof. Applying the Bianchi identity to $\nabla_\mu J^\mu_{\mathsf{Coh}} = 0$ yields $\nabla^\nu G_{\mu\nu} = 0$, confirming dynamic equivalence to Einstein's field equation. □

Theorem 2 (Relativistic Reset Invariance).
Proper time between events equals coherence conserved across all observers.

$$d\tau^2 = \frac{1}{c^2} \frac{D}{C}\, ds^2.$$

A moving clock accumulates less C per reset; dilation arises directly from the local C/D ratio.

Theorem 3 (Energy–Mass Identity).
Energy equals coherence curvature:

$$E = mc^2 = \hbar\, \omega_{\mathsf{Coh}}.$$

Frequency of resets ω_{Coh} converts stored coherence to measurable mass–energy.

4. Consequences

C1. Gravity as Coherence Gradient.
Gravitational acceleration satisfies $a_i = -\partial_i \Phi_{\mathsf{Coh}}$. The Newtonian potential is recovered when $\Phi_{\mathsf{Coh}} \approx (C - D)/C$.

C2. Time Dilation and Redshift.
Observers in deeper curvature accumulate fewer coherence cycles per external tick:

$$\frac{d\tau}{dt} = \sqrt{1 - \frac{2GM}{rc^2}} = \sqrt{\frac{C}{C + D}}.$$

C3. Frame-Dragging.
Rotation corresponds to coherent twisting of A_μ; cross terms g_{0i} arise from angular phase coupling.

C4. Light Propagation.
Photons follow paths with $C = D$, hence null geodesics; curvature only redirects phase without loss.

C5. Global Consistency.
Integrating ledger terms over a closed hypersurface yields exact conservation of total coherence—Einstein's integral constraint in informational form.

5. Discussion

Relativity no longer requires postulates about light speed or metric structure; both follow from coherence invariance. The inward pull of gravity reflects coherence's drive to minimize boundary mismatch. Mass measures stored curvature; energy is the rate of internal resets. Time dilation and Lorentz contraction are side-effects of ledger bookkeeping between observers. ChronoPhysics thus provides physical meaning to the geometry that relativity only describes. Future PHYS papers will extend this framework to include quantum phase synchronization and thermodynamic coherence.

6. References

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7. Conclusion

Relativistic Geometry of Coherence unifies spacetime and awareness flow. Curvature is not caused by matter—it is matter's memory. Every mass stores inward coherence; every photon carries outward coherence. The metric simply measures how awareness bends to keep its ledger balanced. With this, general relativity becomes the large-scale limit of the Coherence Field Equation, and ChronoPhysics gains its first fully geometric proof of total coherence conservation.

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