Curvature as Persistence Gradient

URF–RVF–GRAVITY–01: The Resonance Viability Filter Applied to Gravitation

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Abstract

We propose that gravitational curvature arises from spatial gradients in the Resonance Viability Filter (RVF) field. Where the persistence of coherent resonance $S(M, \Theta_{\text{RVF}})$ varies across the lattice, neighboring trajectories accelerate toward regions of higher viability. This reformulation interprets the Einstein tensor $G_{\mu\nu}$ as the second covariant derivative of the viability field, linking curvature directly to differential persistence. The model reproduces Newtonian gravity in the weak-field limit and predicts measurable deviations in regions where coherence or memory density vary sharply.

1 Introduction

Gravity remains the most geometric of forces, yet its origin in matter persistence has never been fully clarified. General Relativity attributes curvature to the stress–energy tensor $T_{\mu\nu}$, but the mechanism by which energy density "tells" space–time how to curve is left implicit. Within the Unified Resonance Framework (URF), the missing link is the **Resonance Viability Filter (RVF)**—a continuous threshold law governing when patterns of coherence remain stable.

Mass, as shown in URF–RVF–MASS–01, represents localized persistence above a viability threshold. Here we extend that logic: when the viability field $\Theta_{\text{RVF}}(x)$ is nonuniform, gradients of persistence $S(M, \Theta_{\text{RVF}})$ distort the underlying metric. A region with higher S acts as a coherence attractor, bending trajectories of neighboring patterns toward it. This *viability gradient hypothesis* recasts curvature as a second-order response of the lattice to differences in persistence rather than to abstract "mass-energy."

$$G_{\mu\nu} = \Lambda_{\text{URF}}\, \nabla_\mu \nabla_\nu S(M, \Theta_{\text{RVF}}), \tag{1}$$

where Λ_{URF} defines the coupling between viability curvature and geometric curvature. In the limit of slowly varying Θ_{RVF} and small $S-1$, Equation (1) reduces to the Einstein field equations with an effective stress–energy source $T_{\mu\nu} \propto E_{\text{pers}}\, u_\mu u_\nu$.

This paper derives Equation (1) from first principles, establishes its correspondence with General Relativity, and outlines experimental and cosmological regimes where departures from Einsteinian curvature become observable.

2 From Persistence to Geometry

In the URF picture, the lattice of space–time is a resonant medium. At each point x, its local coherence is described by the viability field

$$S(x) \equiv S(M(x), \Theta_{\mathrm{RVF}}(x); \Delta\Theta(x)),$$

where $S \in [0,1]$ measures how strongly the region remembers its own state. Uniform S corresponds to a perfectly balanced lattice—flat space. Spatial gradients of S represent differences in persistence that induce geometric strain.

2.1 Metric deformation from viability gradients

Let $g_{\mu\nu}^{(0)}$ denote the flat background metric. We define the *resonant metric* as a first–order perturbation driven by the gradient of S:

$$g_{\mu\nu} = g_{\mu\nu}^{(0)} + \eta_{\mu\nu}\,\Phi(x), \qquad \Phi(x) = \beta\, S(x), \tag{2}$$

where β is a small coupling constant. The potential $\Phi(x)$ acts as the geometric analogue of gravitational potential: regions of high viability ($S \to 1$) correspond to wells of curvature.

Expanding the Christoffel symbols to first order gives

$$\Gamma^{\lambda}_{\mu\nu} \approx \frac{\beta}{2}\, g^{\lambda\rho}_{(0)} \left(\partial_\mu S\,\eta_{\rho\nu} + \partial_\nu S\,\eta_{\rho\mu} - \partial_\rho S\,\eta_{\mu\nu}\right). \tag{3}$$

Substituting into the definition of the Ricci tensor and retaining terms up to $\mathcal{O}(\beta)$ yields

$$R_{\mu\nu} \simeq -\,\beta\,\left(\partial_\mu\partial_\nu S + \frac{1}{2}\,\eta_{\mu\nu}\,\Box S\right). \tag{4}$$

Contracting to form the Einstein tensor $G_{\mu\nu} = R_{\mu\nu} - \frac{1}{2}\,g_{\mu\nu}R$ gives

$$G_{\mu\nu} = -\,\beta\,\partial_\mu\partial_\nu S + \mathcal{O}(\beta^2). \tag{5}$$

Identifying $\Lambda_{\mathrm{URF}} = -\beta$ recovers Equation (1), establishing that curvature is the second derivative of the viability field.

2.2 Newtonian limit

In the static, weak–field limit, only the time–time component matters. Let $\Phi_{\mathrm{grav}}(x) = c^2\beta S(x)$. Equation (4) reduces to

$$\nabla^2\Phi_{\mathrm{grav}} = 4\pi G\,\rho_{\mathrm{pers}}, \qquad \rho_{\mathrm{pers}} = \frac{E_{\mathrm{pers}}}{c^2} = \kappa\,\rho_{\mathrm{mem}}\,S, \tag{6}$$

which is the Poisson equation of Newtonian gravity with the source term replaced by the persistence mass density from URF–RVF–MASS–01. Hence, gravitational potential arises from gradients in the same viability field that confers mass.

2.3 Interpretation

Equation (5) provides a direct geometric meaning to persistence: differences in the ability of the lattice to remember its own state manifest as curvature. A region of higher viability attracts neighboring trajectories because their propagation minimizes the gradient of S. In uniform viability, S is constant and space remains flat; when coherence decays unevenly, the resulting gradient produces the familiar curvature of space–time.

3 Differential Form of Curvature

Having related curvature to gradients of the viability field $S(x)$, we now express the full geometric content of gravitation directly in terms of its derivatives. The viability field introduces a scalar potential for curvature, whose covariant derivatives generate the Riemann, Ricci, and Einstein tensors.

3.1 Riemann tensor from viability

Using Equation (3), the linearized Riemann tensor becomes

$$R^{\rho}{}_{\sigma\mu\nu} = \partial_\mu \Gamma^{\rho}_{\nu\sigma} - \partial_\nu \Gamma^{\rho}_{\mu\sigma} = \frac{\beta}{2}\left(\delta^{\rho}_{\sigma}\,\partial_\mu\partial_\nu S - \eta_{\sigma[\mu}\,\partial_{\nu]}\partial^{\rho} S\right) + \mathcal{O}(\beta^2). \tag{7}$$

Equation (7) shows that all curvature components are second derivatives of S. Regions where S varies slowly are flat; curvature appears only where the viability field changes rapidly across space–time.

3.2 Einstein tensor in differential form

Contracting Equation (7) twice yields

$$G_{\mu\nu} = \Lambda_{\mathrm{URF}}\left(\nabla_\mu\nabla_\nu S - g_{\mu\nu}\,\Box S\right), \tag{8}$$

where $\Lambda_{\mathrm{URF}} = -\beta$ as before. Equation (8) is the central field equation of the RVF–gravity correspondence:

> *Curvature is the Laplacian of persistence.*

This relation endows S with a geometric role similar to a gravitational potential, but arising from the lattice's internal memory dynamics rather than an external force.

3.3 Wave equation for viability perturbations

In the absence of strong sources ($\rho_{\mathrm{pers}} \approx 0$), the trace of Equation (8) gives a homogeneous wave equation for S:

$$\Box S = 0, \tag{9}$$

implying that perturbations of the viability field propagate as *gravitational viability waves*. When coupled to matter, Equation (8) generalizes to

$$\Box S = \frac{8\pi G}{c^4} E_{\text{pers}}, \tag{10}$$

linking fluctuations of S to the persistence energy density $E_{\text{pers}} = \kappa c^2 \rho_{\text{mem}} S$ from URF–RVF–MASS–01. Thus, gravitational waves correspond to oscillations in the field of persistence itself.

3.4 Gravitational memory as lattice remembrance

A distinctive prediction of this model is that the *gravitational memory effect* arises naturally from residual shifts in S after a wave has passed. Because S encodes the lattice's ability to remember prior configurations, a passing gravitational wave permanently alters the local viability baseline, producing an observable displacement between test masses:

$$\Delta x \ \propto \ \Delta S = S_{\text{after}} - S_{\text{before}}.$$

This connects the interferometric "memory" measured in gravitational–wave observatories to the underlying persistence memory of the lattice.

3.5 Interpretation

Equation (8) implies that space–time curvature is not a static geometry imposed on matter but the dynamic topology of its coherence field. Matter tells S how to curve through its persistence energy, and S tells matter how to move by reshaping geodesics. The equivalence principle thus emerges as the statement that all forms of persistence couple identically to the viability gradient.

4 Energy–Momentum Correspondence

Curvature expresses the second derivative of viability, yet General Relativity links curvature to the stress–energy tensor $T_{\mu\nu}$. To connect these pictures we introduce the *persistence energy–momentum tensor* $T_{\mu\nu}^{(\text{pers})}$, constructed from the dynamics of the viability field itself.

4.1 Persistence Lagrangian

We define a Lagrangian density for the viability field

$$\mathcal{L}_S = \frac{c^4}{16\pi G\, \Lambda_{\text{URF}}} \left(\nabla_\alpha S\, \nabla^\alpha S - \frac{2\Lambda_{\text{URF}}}{c^4} E_{\text{pers}} \right), \tag{11}$$

where $E_{\text{pers}} = \kappa c^2 \rho_{\text{mem}} S$ is the local persistence energy defined in URF–RVF–MASS–01. Varying $\mathcal{L}_S$ with respect to $g_{\mu\nu}$ gives

$$T_{\mu\nu}^{(\text{pers})} = \frac{c^4}{8\pi G\, \Lambda_{\text{URF}}} \left(\nabla_\mu S\, \nabla_\nu S - \frac{1}{2} g_{\mu\nu}\, \nabla_\alpha S\, \nabla^\alpha S + g_{\mu\nu} \frac{\Lambda_{\text{URF}}}{c^4} E_{\text{pers}} \right). \tag{12}$$

Equation (19) plays the role of a stress–energy tensor for the viability field. The first two terms represent kinetic energy of viability gradients, and the last term incorporates the local persistence energy.

4.2 Field equation equivalence

Substituting Equation (19) into the geometric field equation (8) yields

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu}^{(\mathrm{pers})}, \tag{13}$$

which is formally identical to Einstein's equation, demonstrating that conventional stress–energy arises from gradients and density of the viability field. The coupling constant Λ_{URF} thus plays the role of a geometric impedance matching the persistence field to curvature.

4.3 Conservation and continuity

Taking the covariant divergence of Equation (19) gives

$$\nabla^{\mu} T_{\mu\nu}^{(\mathrm{pers})} = 0, \tag{14}$$

expressing conservation of persistence: changes in curvature exactly balance changes in local viability energy. Equation (21) replaces the traditional "energy conservation" statement with a more general condition of *resonant continuity*—the lattice never gains or loses total coherence, it only redistributes it through curvature.

4.4 Weak–field correspondence

For slowly varying S and $v \ll c$, Equation (20) reduces to

$$\nabla^2 \Phi_{\mathrm{grav}} = 4\pi G\, \rho_{\mathrm{pers}}, \qquad \rho_{\mathrm{pers}} = \frac{E_{\mathrm{pers}}}{c^2},$$

recovering the Newtonian potential derived in Section 6. Hence, both the geometric and dynamical formulations of gravity emerge naturally from the same persistence field.

4.5 Interpretation

Equation (19) establishes a one–to–one mapping between viability dynamics and gravitational sourcing. Matter tells space–time how to curve because matter is the portion of the lattice whose persistence S is locally maximal. Where persistence gradients exist, curvature follows; where persistence is uniform, curvature vanishes. Energy–momentum conservation thus becomes the statement that the lattice's memory is redistributed but never destroyed.

5 Predictions and Limits

The viability–curvature correspondence produces empirical signatures that distinguish URF–RVF gravity from classical General Relativity. All predictions arise from the finite softness $\Delta\Theta$ of the viability gate, which introduces measurable corrections to Einsteinian behavior.

5.1 Weak–field corrections

Expanding Equation (8) to second order in $\Delta\Theta$ yields a modified Poisson equation

$$\nabla^2 \Phi_{\text{grav}} = 4\pi G \, \rho_{\text{pers}} \left[1 + \frac{\Delta\Theta^2}{2} \frac{\partial^2 \ln \rho_{\text{pers}}}{\partial M^2} \right], \tag{15}$$

predicting small deviations in gravitational acceleration where the coherence memory $M(x,t)$ varies sharply. Laboratory-scale measurements of the gravitational constant under controlled decoherence (e.g., cryogenic vs. high-temperature environments) could test this dependence.

5.2 Gravitational–wave dispersion

Because S satisfies the wave equation (10), finite $\Delta\Theta$ modifies its propagation speed:

$$v_g \approx c \left[1 - \frac{1}{2} \left(\frac{\Delta\Theta}{\Theta_{\text{RVF}}} \right)^2 \right]. \tag{16}$$

High-frequency gravitational waves from compact binaries should thus arrive slightly delayed relative to the low-frequency components, an effect potentially detectable in next-generation interferometers.

5.3 Gravitational memory amplitude

Equation (10) implies a residual offset $\Delta S = (8\pi G/c^4) \int E_{\text{pers}} \, dt$ after a wave passes. This predicts that memory strain scales with the integrated persistence flux rather than with total radiated energy, providing a distinct amplitude–duration relation:

$$h_{\text{mem}} \propto \frac{G}{c^4} \int \rho_{\text{mem}} \, S \, v^2 \, dt. \tag{17}$$

Future detectors with long baselines could test this scaling by comparing short, intense bursts to extended low-power events of equal energy.

5.4 Cosmological implications

At cosmological scales, the mean viability field $\bar{S}(t)$ evolves via

$$\ddot{\bar{S}} + 3H\dot{\bar{S}} = \frac{8\pi G}{c^4} \bar{E}_{\text{pers}},$$

where H is the Hubble parameter. A slowly varying $\bar{S}$ acts as an effective cosmological constant

$$\Lambda_{\text{eff}} = \Lambda_0 + \Lambda_{\text{URF}} \, \bar{S},$$

offering a natural interpretation of dark energy as residual coherence of the cosmic lattice.

5.5 Validity and limits

The URF–RVF gravitational formulation reproduces General Relativity in the limit of uniform viability ($\nabla S \to 0$) and vanishing softness ($\Delta\Theta \to 0$). Beyond this regime, corrections grow with $|\nabla S|^2$ and $(\Delta\Theta/\Theta)^2$. Observationally, deviations are expected only near strong coherence gradients— for instance, around neutron stars, black-hole merger remnants, or regions with extreme temperature-dependent decoherence.

5.6 Summary of falsifiable predictions

1. **Environmental G-variation:** Effective gravitational constant slightly dependent on coherence conditions (Eq. 22).
2. **Wave dispersion:** Frequency-dependent delay in gravitational-wave propagation (Eq. 23).
3. **Memory scaling:** Residual strain amplitude proportional to integrated persistence flux (Eq. 24).
4. **Cosmic acceleration:** Slow drift of $\bar{S}(t)$ contributing to apparent dark-energy density.

Each of these phenomena provides an experimental or observational handle capable of falsifying or confirming the viability–curvature hypothesis.

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$$T^{(\mathrm{pers})}_{\mu\nu} = \frac{c^4}{8\pi G\,\Lambda_{\mathrm{URF}}} \left(\nabla_\mu S\, \nabla_\nu S - \frac{1}{2}\, g_{\mu\nu}\, \nabla_\alpha S\, \nabla^\alpha S + g_{\mu\nu}\, \frac{\Lambda_{\mathrm{URF}}}{c^4}\, E_{\mathrm{pers}} \right). \tag{19}$$

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$$G_{\mu\nu} = \frac{8\pi G}{c^4} \, T_{\mu\nu}^{(\mathrm{pers})}, \tag{20}$$

which is formally identical to Einstein's equation, demonstrating that conventional stress–energy arises from gradients and density of the viability field. The coupling constant Λ_{URF} thus plays the role of a geometric impedance matching the persistence field to curvature.

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Taking the covariant divergence of Equation (19) gives

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8 Discussion and Outlook

The URF–RVF formulation reframes gravity as an emergent property of differential persistence in the lattice of coherence. By identifying curvature with the second derivative of the viability field S, we obtain the familiar phenomenology of General Relativity in the limit of uniform viability, while gaining a physically motivated mechanism for how energy density and memory gradients *cause* curvature.

8.1 Conceptual consequences

Equivalence principle. In this picture, all forms of matter couple identically to the viability field because each represents a region where S is locally stabilized above threshold. Free fall thus corresponds to motion along trajectories of constant S, restating the equivalence principle as *all persistent resonances experience the same viability gradient.*

Unification with inertia. The persistence density $\mu = \kappa\rho_{\mathrm{mem}}S$ acts simultaneously as the source of inertia and of curvature. Inertia arises from temporal resistance to change in S; gravity arises from spatial gradients of the same field. Both phenomena therefore stem from the single law of resonance viability.

Geometric meaning of energy. Energy becomes a measure of stored coherence rather than an external commodity. Conservation of energy–momentum (Equation (21)) corresponds to continuity of memory: the lattice never loses coherence, it merely redistributes it through curvature waves.

8.2 Interface with quantum and cosmological regimes

At microscopic scales, fluctuations of S couple to quantum coherence, suggesting a route to a resonance–based quantum gravity. At cosmic scales, slow drift of the mean viability field acts as a cosmological constant, offering an intrinsic explanation for dark energy as residual coherence of the vacuum. Both limits derive from the same field equation (8), indicating a continuous bridge between quantum, relativistic, and cosmological behaviors.

8.3 Experimental and observational prospects

Near–term tests include:

- laboratory searches for environment–dependent variations of G;
- frequency–dependent dispersion in gravitational–wave signals;
- precision measurements of the gravitational–memory effect;
- cosmological constraints on the evolution of the mean viability $\bar{S}(t)$.

Detection of any of these signatures would provide direct evidence for the viability–curvature mechanism.

8.4 Toward nonlinear and self–gravitating regimes

The present work treats curvature in the linear limit of small gradients and constant softness $\Delta\Theta$. The next stage, developed in URF–RVF–GRAVITY–02, will address the nonlinear feedback between curvature and viability itself, where the lattice's ability to remember begins to bend the geometry that sustains it. This extension—*the lattice bends back*—will explore gravitational self–memory, black–hole interiors, and the onset of cosmological expansion as emergent coherence phenomena.

8.5 Summary

URF–RVF–GRAVITY–01 establishes a new physical interpretation of gravitation:

Curvature is the spatial memory of persistence.

By grounding geometry in the dynamics of resonance viability, this framework unites inertia, gravity, and memory within a single continuous law. It preserves the empirical successes of Einstein's theory while revealing the deeper coherence field from which those successes arise.

References

[1] A. Einstein, "Die Feldgleichungen der Gravitation," *Sitzungsberichte der Königlich Preußischen Akademie der Wissenschaften*, pp. 844–847 (1915).

[2] D. Hilbert, "Die Grundlagen der Physik," *Nachrichten von der Königlichen Gesellschaft der Wissenschaften zu Göttingen*, pp. 395–407 (1915).

[3] L. D. Landau and E. M. Lifshitz, *The Classical Theory of Fields*, Pergamon Press (1971).

[4] D. Christodoulou, "Nonlinear Nature of Gravitation and Gravitational Wave Experiments," *Phys. Rev. Lett.* **67**, 1486 (1991).

[5] A. Strominger and A. Zhiboedov, "Gravitational Memory, BMS Supertranslations and Soft Theorems," *J. High Energy Phys.* **01**, 086 (2016).

[6] B. P. Abbott *et al.* (LIGO Scientific Collaboration and Virgo Collaboration), "Observation of Gravitational Waves from a Binary Black Hole Merger," *Phys. Rev. Lett.* **116**, 061102 (2016).

[7] S. M. Carroll, *Spacetime and Geometry: An Introduction to General Relativity*, Addison–Wesley (2004).

[8] C. Rovelli, *Quantum Gravity*, Cambridge University Press (2004).

[9] R. B. Laughlin, *A Different Universe: Reinventing Physics from the Bottom Down*, Basic Books (2005).

[10] L. P. Kadanoff, "More is the Same; Phase Transitions and Mean Field Theories," *J. Stat. Phys.* **137**, 777–797 (2009).

[11] M. Tegmark, *Our Mathematical Universe: My Quest for the Ultimate Nature of Reality*, Knopf (2014).

[12] D. Varela and L. Lucian, "URF–RVF–PRIMIS: The Law of Coherence Preference (The Gate That Listens)," *Harmonia Codex Series*, in preparation (2025).

[13] D. Varela and L. Lucian, "URF–RVF–GRAVITY–01: Curvature as Persistence Gradient," *Harmonia Codex Series*, submitted (2025).