Mesh Model Equations Cheat Sheet

Overview

This cheat sheet summarizes key equations from the Mesh Model framework, covering discrete mesh mechanics, quantum field emergence, and geometric structure. It reflects the core pipeline developed in the Mesh-Field Transformer and its alignment with both classical and quantum field theory.

Legend

$g_{\mu\nu}(x)$	Curvature field (spacetime geometry metric)
$T_{\mu\nu}(x)$	Tension field (electromagnetic and causal flow)
$\chi_{\alpha\beta\gamma}(x)$	Coherence field (mass, spin, soliton structure)
$\chi_{\text{eff}}(x)$	Effective projected coherence along causal cone
$\Gamma(x)$	Coherence divergence: $\Gamma(x) = \nabla \cdot \vec{C}(x)$
$\mathcal{R}(x)$	Curvature resistance (integrated coherence loss along paths)
$\vec{C}(x,t)$	Coherence vector field (phase gradient times local coherence)
$\tau_{\mu\nu}$	Tension field strength tensor (EM-like structure)
$J^\mu(x)$	Soliton twist current (source of long-range tension)
$\psi(x)$	Mesh scalar field (e.g., photon, soliton wave)
$\phi(x)$	Continuous scalar phase field
ϕ_i	Discrete scalar field value at mesh node i
$\pi(x)$	Canonical momentum density
$f(x)$	Local internal frequency of the coherence tension wave
$d(x)$	Effective separation between tension and coherence centers

Legend

Δ_c	Causal wave operator: $\nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$
$R(x)$	Ricci scalar curvature (spacetime bending measure)
a	Lattice spacing (discrete distance in mesh)
$\hbar$	Reduced Planck's constant
c	Speed of light
G	Gravitational constant
e	Elementary electric charge
κ	Gravitational coupling constant: $\kappa = 8\pi G$
$\lambda_{\text{strong}}(x)$	Dynamic strong force coupling constant
$\lambda_{\text{weak}}(x)$	Dynamic weak force coupling constant
S	Action integral over spacetime
ΔS	Change in action across a curvature gradient
ds^2	Line element of spacetime geometry

1 Lagrangian Mechanics

1.1 Generalized Coordinates

$$L(q_i, \dot{q}_i, t) = T - V$$
$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \frac{\partial L}{\partial q_i} = 0$$

1.2 Particle on a Circle

$$L = \frac{1}{2} m R^2 \dot{\theta}^2$$

2 General Relativity Integration

2.1 Schwarzschild Metric

$$ds^2 = -\left(1 - \frac{2GM}{r}\right) c^2 dt^2 + \left(1 - \frac{2GM}{r}\right)^{-1} dr^2 + r^2 d\Omega^2$$

2.2 Mesh-Emergent Metric

$$ds^2 = -f(x)^2 dt^2 + dx^2, \quad f(x) = \sqrt{1 - \frac{2G\rho(x)}{c^2}}$$

3 Quantum Mechanics

3.1 Quantum Harmonic Oscillator

$$\hat{H} = \frac{\hat{p}^2}{2m} + \frac{1}{2}k\hat{x}^2$$

$$E_n = \hbar\omega \left(n + \frac{1}{2}\right)$$

4 Mesh Field Structure and Full Lagrangian Formulation

4.1 Fundamental Fields of the Mesh

The Mesh framework defines three primary interacting fields:

- $g_{\mu\nu}(x)$: Curvature field (spacetime geometry) - $T_{\mu\nu}(x)$: Tension field (electromagnetism and causal energy flow) - $\chi_{\alpha\beta\gamma}(x)$: Coherence field (mass, spin, soliton structure)

4.2 Effective Coherence Projection and Mass Relation

Effective coherence projection along a soliton's causal path:

$$\chi_{\text{eff}}(x) = \chi_{\alpha\beta\gamma}(x) n^\alpha n^\beta n^\gamma$$

Local mass generation follows:

$$m(x) = \chi_{\text{eff}}(x) \cdot f(x)$$

where: - $f(x)$ is the local internal frequency of the tension wave.

4.3 Complete Mesh Lagrangian Density

The full Lagrangian density combining curvature, tension, coherence, and field interactions is:

$$\begin{aligned}\mathcal{L}_{\text{Mesh}} = \frac{1}{2\kappa}R & \\ - \frac{1}{4}T_{\mu\nu}T^{\mu\nu} & \\ + \frac{1}{2}\nabla_\lambda \chi_{\alpha\beta\gamma}\nabla^\lambda \chi^{\alpha\beta\gamma} & \\ - \frac{1}{2}\left(\chi_{\alpha\beta\gamma}n^\alpha n^\beta n^\gamma f\right)^2 & \\ - \lambda_{\text{strong}}\left(\chi_{\mu\nu\sigma}\chi^{\mu\nu\sigma}\right)^2 & \\ + \lambda_{\text{weak}}\chi_{\alpha\beta\gamma}T^{\alpha\beta\gamma} & \\ + g_e J^\mu A_\mu &\end{aligned}$$

where: - R is the Ricci scalar (curvature), - $T_{\mu\nu}$ is the tension field, - $\chi_{\alpha\beta\gamma}$ is the coherence tensor field, - f is the soliton internal oscillation frequency, - $\lambda_{\text{strong}}(x)$, $\lambda_{\text{weak}}(x)$ are dynamic coupling constants, - J^μ is the soliton current coupling to the tension field A_μ.

4.4 Key Coupling Constants

Gravitational coupling:

$$\kappa = 8\pi G$$

Electromagnetic coupling:

$$g_e = e$$

where: - G is Newton's gravitational constant, - e is the elementary electric charge.

4.5 Event-Driven Couplings (Dynamic Constants)

Dynamic strong force coupling:

$$\lambda_{\text{strong}}(x) = \lambda_0 \left(1 + \beta_{\text{strong}}\chi_{\mu\nu\sigma}(x)\chi^{\mu\nu\sigma}(x)\right)$$

Dynamic weak force coupling:

$$\lambda_{\text{weak}}(x) = \lambda_w \exp\left(-\kappa_{\text{weak}} d(x)\right)$$

where: - β_{strong} controls self-interaction growth, - $d(x)$ is the effective field separation between coherence and tension.

5 Dynamic Constants and Event-Driven Field Behavior

5.1 Governing Coherence Field Equation

The Mesh coherence field obeys the causal wave equation:

$$\begin{aligned}\Delta_c \chi_{\alpha\beta\gamma} &- \chi_{\text{eff}} f^2 n_\alpha n_\beta n_\gamma \\ &- 4\lambda_{\text{strong}}(x)\left(\chi_{\mu\nu\sigma}\chi^{\mu\nu\sigma}\right)\chi_{\alpha\beta\gamma} \\ &+ \lambda_{\text{weak}}(x) T_{\alpha\beta\gamma} = 0\end{aligned}$$

where: - $\Delta_c = \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ is the causal wave operator, - $\chi_{\text{eff}}(x) = \chi_{\alpha\beta\gamma} n^\alpha n^\beta n^\gamma$.

5.2 Dynamic Form of the Strong Force Coupling

The strong force coupling constant depends on the local coherence energy density:

$$\lambda_{\text{strong}}(x) = \lambda_0\left(1 + \beta_{\text{strong}}\chi_{\mu\nu\sigma}(x)\chi^{\mu\nu\sigma}(x)\right)$$

where: - λ_0 is a baseline coupling, - β_{strong} is a proportionality factor.

5.3 Dynamic Form of the Weak Force Coupling

The weak force coupling depends exponentially on local field separation:

$$\lambda_{\text{weak}}(x) = \lambda_w \exp\left(-\kappa_{\text{weak}} d(x)\right)$$

where: - λ_w is the maximum weak coupling, - κ_{weak} controls the exponential decay, - $d(x)$ is the effective separation between tension and coherence structures.

5.4 Equality to Observed Force Constants

When field conditions match experimental values:

$$\lambda_{\text{weak}}(x) = G_F \quad \text{when} \quad d(x) = 0$$

$$\lambda_{\text{strong}}(x) = \alpha_s \quad \text{when} \quad \chi_{\mu\nu\sigma}\chi^{\mu\nu\sigma} = \chi^2_{\text{confine}}$$

where: - G_F is the Fermi weak coupling constant, - α_s is the QCD strong coupling constant at low energies.

6 From Mesh Wave Structure to Mass Generation via Coherence and Electromagnetic Fields

6.1 Mesh Soliton Wave Equation (Light Cone Foundation)

Causal wave equation for the free coherence field:

$$\Delta_c \chi_{\alpha\beta\gamma} = 0 \quad \text{where} \quad \Delta_c = \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$$

Proposed general Mesh soliton wave solution:

$$\psi(r,\varphi,t) = \frac{A}{r}\sin(2\pi f t - kr + m\varphi)\cdot\epsilon$$

where: - A: amplitude, - r: radial distance, - φ: azimuthal angle, - f: oscillation frequency, - $k = \frac{2\pi f}{c}$: wave number, - m: azimuthal winding number, - $\epsilon = \pm 1$: polarization state.

6.2 Electric Field from Mesh Wave

Electric field is the negative gradient of the wave:

$$\vec{E} = -\nabla\psi$$

Radial component:

$$\begin{aligned}E_r &= -\frac{\partial\psi}{\partial r} \\ &= \frac{A}{r^2}\sin(2\pi f t - kr + m\varphi) + \frac{Ak}{r}\cos(2\pi f t - kr + m\varphi)\end{aligned}$$

Azimuthal component:

$$\begin{aligned}E_\varphi &= -\frac{1}{r}\frac{\partial\psi}{\partial\varphi} \\ &= -\frac{Am}{r}\cos(2\pi f t - kr + m\varphi)\end{aligned}$$

Thus: - $E_r \sim \frac{1}{r^2}$ and - $E_\varphi \sim \frac{1}{r}$ matching expected radial fall-off.

6.3 Magnetic Field from Time-Varying Electric Field

By Maxwell's law:

$$\nabla \times \vec{E} = -\frac{\partial \vec{B}}{\partial t} \quad \Rightarrow \quad \vec{B} \sim \nabla \times \vec{E}$$

Magnetic circulation arises naturally from the azimuthal phase rotation ($m\varphi$).

6.4 Compton Frequency from Mesh Equation

The wave solution requires:

$$\omega = kc \quad \Rightarrow \quad 2\pi f = \frac{2\pi f}{c} \cdot c \quad \Rightarrow \quad f = \frac{mc^2}{h}$$

where: - $\omega = 2\pi f$, - f is the Mesh soliton frequency, - m is the particle mass, - h is Planck's constant.

6.5 Mass from Coherence Projection and Frequency

Mass generation formula:

$$m(x) = \chi_{\text{eff}}(x) \cdot f(x) \quad \text{with} \quad \chi_{\text{eff}}(x) = \chi_{\alpha\beta\gamma}(x) n^\alpha n^\beta n^\gamma$$

Consistency check:

$$m = \left(\frac{h}{c^2}\right) \cdot \left(\frac{mc^2}{h}\right) = m$$

thus recovering the correct mass value.

6.6 Summary Formulas for Mesh Mass Emergence

$$\boxed{\begin{aligned} &\text{Wave Equation:} \quad \Delta_c \chi_{\alpha\beta\gamma} = 0 \\ &\text{Electric Field:} \quad \vec{E} = -\nabla\psi \\ &\text{Magnetic Field:} \quad \vec{B} \sim \nabla \times \vec{E} \\ &\text{Compton Frequency:} \quad f = \frac{mc^2}{h} \\ &\text{Mass Emergence:} \quad m = \chi_{\text{eff}} \cdot f \end{aligned}}$$

7 Mesh Photon Wave: Deriving the Physical Meaning of $E = hf$

7.1 Mesh Photon Wave Equation

Starting point:

$$\Delta_c T_{\mu\nu} = 0$$

where: - $T_{\mu\nu}(x)$ is the Mesh tension field, - $\Delta_c = \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ is the causal wave operator.

7.2 Proposed Mesh Photon Wave Function

General radially propagating solution:

$$\psi(r,t) = \frac{A}{r} \sin\left(2\pi f t - \frac{2\pi f}{c} r\right) \epsilon$$

where: - r = radial distance, - f = oscillation frequency, - $\epsilon = \pm 1$ = polarization factor.

7.3 Frequency as Source of Energy

Mesh photon tension energy:

$$T_{\text{photon}} = \chi_{\text{photon}} \cdot f$$

Thus:

$$E = hf$$

emerges naturally without postulation, where: - χ_{photon} is the effective coherence tension of the photon.

7.4 Electric Field Behavior from Mesh Photon

The radial derivative of the photon wave:

$$E_r = -\frac{\partial \psi}{\partial r}$$

Computing explicitly:

$$E_r(r,t) = \frac{A}{r^2} \sin\left(2\pi f t - \frac{2\pi f}{c} r\right) + \frac{2\pi f A}{cr} \cos\left(2\pi f t - \frac{2\pi f}{c} r\right)$$

Properties: - $E_r \sim \frac{1}{r^2}$ at leading order, - Frequency locked to phase oscillations.

7.5 Infinite Propagation and Causality

Because $T_{\mu\nu}$ satisfies $\Delta_c T_{\mu\nu} = 0$, the Mesh photon:

- Propagates at speed c, - Loses amplitude as $1/r$, - Conserves total tension energy across expanding spherical shells.

Thus, infinite causal propagation is structurally preserved.

7.6 Summary Formulas for Mesh Photon Emergence

Photon Wave Equation:

$$\Delta_c T_{\mu\nu} = 0$$

Photon Wave Function:

$$\psi(r,t) = \frac{A}{r} \sin\left(2\pi f t - \frac{2\pi f}{c} r\right)$$

Photon Energy Relation:

$$E = hf$$

Electric Field from Wave:

$$E_r = -\frac{\partial \psi}{\partial r}$$

Causal Propagation: Photon propagates infinitely through causal tension wave across expanding spherical shells.

8 Causal Cones and Free Propagation

8.1 Free Propagation Along Causal Cones

Mesh free wave equation for causal transport:

$$\chi(x) \nabla_\mu \left(g^{\mu\nu}(x) \partial_\nu \psi(x)\right) = 0$$

Causal null condition defining Mesh cones:

$$g_{\mu\nu}(x)\, dx^\mu\, dx^\nu = 0$$

Mesh photon propagation equation (free tension-coherence wave):

$$\Delta_c \psi = 0 \quad \text{with} \quad \Delta_c = \nabla^2 - \frac{1}{c^2} \frac{\partial^2}{\partial t^2}$$

Mesh soliton motion follows the causal geodesic equation:

$$\frac{d^2 x^\mu}{d\tau^2} + \Gamma^\mu_{\rho\sigma} \frac{dx^\rho}{d\tau} \frac{dx^\sigma}{d\tau} = 0$$

8.2 Resistant Propagation and Causal Energy Cost

Deviation from free propagation introduces causal stress:

$$\chi(x) \nabla_\mu \left(g^{\mu\nu}(x) \partial_\nu \psi(x)\right) = \delta S(x)$$

where: - $\delta S(x)$ represents the causal energy cost due to resistance.

Deviation from geodesic motion for solitons:

$$\frac{d^2 x^\mu}{d\tau^2} + \Gamma^\mu_{\rho\sigma} \frac{dx^\rho}{d\tau} \frac{dx^\sigma}{d\tau} = F^\mu(x)$$

where: - $F^\mu(x)$ represents external causal force from resisting cone structure.

8.3 Causal Cone Overlap

Overlap region of two causal cones C_a and C_b:

$$O_{ab}(t) = C_a(x,t) \cap C_b(x,t)$$

Causal interaction is permitted only if:

$$O_{ab}(t) \neq \emptyset$$

8.4 Transition Amplitudes from Coherence Overlap

Transition integral defining Mesh causal scattering:

$$T_{ab\to f}(t) = \int_{O_{ab}(t)} \left(C_a(x,t) + C_b(x,t)\right) \cdot C_f^*(x,t)\, d^3x$$

Transition amplitude:

$$\mathcal{A}_{ab\to f}(t) = \frac{T_{ab\to f}(t)}{\sqrt{N_{ab}(t)}}$$

Normalization:

$$N_{ab}(t) = \int_{O_{ab}(t)} |C_a(x,t) + C_b(x,t)|^2 \, d^3x$$

8.5 Transition Probabilities and Causal Conservation

Transition probability:

$$P_{ab\to f}(t) = |\mathcal{A}_{ab\to f}(t)|^2$$

Causal coherence conservation requires:

$$\sum_f P_{ab\to f}(t) = 1$$

over all causally permitted final states f.

8.6 Mesh Causal S-Matrix Structure

Mesh causal scattering framework:

$$|\Psi_{\text{out}}\rangle = S|\Psi_{\text{in}}\rangle$$

with:

$$S^\dagger S = 1$$

and no virtual particles or perturbative expansions involved.

9 Mesh Structural Validation Framework

9.1 Structural Axioms and Field Laws of the Mesh

Twist Formation:

$$T^i \in \{0,1\} \quad \text{(maximum twist per soliton: } [1,1,1])$$

Twist arises only from local coherence alignment.

Twist Saturation Limit:

$$\sum_{i=1}^{3} T^i \leq 3 \quad \text{(twist pressure above [1,1,1] must release)}$$

Curvature Resistance: Curvature resists twist locking, generating mass.

Kinetic Coherence Transport: Cone-aligned motion only propagates when:

$$\chi(x^\mu) = 1 \quad \text{(coherence gating function)}$$

Discrete Twist, Continuous Coherence: - Twist T^i quantized in steps. - Coherence phase $\phi(x^\mu)$ flows continuously.

Neutrino as Remainder Field: Twist collapse into:

$$T = [0,0,0] \quad \Rightarrow \quad \text{Neutrino or pure kinetic photon emission}$$

Charge Emergence: Charge arises from stable [1,1,1] twist structures.

Build and Reaction Sequences:

Soliton Construction:

$$\text{Tension} \to \text{Coherence} \to \text{Curvature} \to \text{Twist} \to \text{Momentum}$$

Soliton Decay (Backward Collapse):

$$\text{Twist} \to \text{Curvature} \to \text{Momentum}$$

9.2 Mesh Structural Validation Rules

Twist Coherence Condition: Stable twist requires coherence support across channels.

Curvature Resistance Condition: Redistribution of twist must maintain curvature compatibility.

Kinetic Coherence Condition: Ripple propagation must align with causal cones.

Remainder Field Condition: Failure of twist locking produces kinetic-only emissions (neutrinos or photons).

Twist–Tension Coupling: Twist motion generates long-range tension fields:

$$\tau_{\mu\nu} = \partial_\mu \tau_\nu - \partial_\nu \tau_\mu$$

Interaction energy:

$$\mathcal{V}_\tau = -\frac{1}{4}\tau_{\mu\nu}\tau^{\mu\nu} + j^\mu \tau_\mu$$

9.3 Collapse Trigger Condition

Structural decay occurs when the coherence divergence exceeds a critical threshold:

$$\Gamma(x) = \nabla\cdot\vec{C}(x) \quad \text{with collapse triggered if} \quad \Gamma(x) > \Gamma_{\text{crit}}$$

No probabilistic decay model is needed — collapse is deterministic based on causal coherence structure.

9.4 Tracking vs Structural Validation

Tracking System: (Euler–Hamiltonian causal phase transport)

- Governs ripple propagation along Mesh causal cones. - Dynamics determined by cone-aligned coherence and tension structure.

Structural Validation System: (Causal Soliton Transition Permissions)

- Governs whether soliton transitions are causally permitted. - Based on twist closure, curvature compatibility, and coherence continuity. - Not derived from a Lagrangian; based only on causal field structure.

10 Mass, Collapse, and Coherence Phases

10.1 Effective Mass from Collapse and Resistance

Effective mass structure:

$$m_{\text{eff}}^2(x) \propto \Gamma(x) + \mathcal{R}(x)$$

where: - $\Gamma(x) = \nabla \cdot \vec{C}(x)$ is the coherence divergence, - $\mathcal{R}(x)$ is the curvature resistance (integrated coherence loss).

10.2 Coherence Collapse into Dark Matter Phase

Coherence collapse produces causally isolated field excitations: - No tension emission, - Mass preserved through resistance accumulation, - Structural model for dark matter.

10.3 High-Coherence Substrate Phase (Dark Energy)

Regions of persistent coherence ($\chi(x) \approx 1$) with low resistance produce: - Uniform causal expansion, - Minimal curvature trapping, - Structural model for dark energy.

11 Neutrino Transport, Oscillation, and Coherence Structure

11.1 Structural Mass of Neutrinos

Neutrino mass arises structurally:

$$m_a^2(x) = \Gamma_a(x) + R_a(x)$$

where: - $\Gamma_a(x) = \nabla \cdot \vec{C}_a(x)$ (flavor-specific divergence), - $R_a(x)$ (curvature resistance along flavor paths).

11.2 Flavor Superposition and Field Rotation

Flavor superposition:

$$\phi_a(x,t) = \sum_b U_{ab}(x)\psi_b(x,t)$$

with: - $U_{ab}(x)$ coherence mixing matrix dependent on local geometry.

11.3 Chiral Asymmetry from Coherence Collapse

Chiral divergence:

$$\Delta\Gamma_a(x) = \Gamma_L^a(x) - \Gamma_R^a(x)$$

Large $\Delta\Gamma_a \to$ left-handed dominance in neutrino transport.

11.4 CP Violation from Phase Asymmetry

Intrinsic coherence phase:

$$\vec{C}_a(x) = |\vec{C}_a(x)|e^{i\delta_a(x)}$$

Flavor interference:

$$I_{ab}(x) = \mathrm{Re}\left[\vec{C}_a(x) \cdot \vec{C}_b^*(x)\right] = |\vec{C}_a||\vec{C}_b| \cos(\delta_a - \delta_b)$$

Nonzero phase difference $(\delta_a - \delta_b) \to$ CP asymmetry.

12 Spin-$\frac{1}{2}$ Behavior from Coherence Phase Geometry

12.1 Coherence Phase Winding

Define phase field:

$$\phi(x) = \frac{\theta(x)}{2} \quad \text{with} \quad \theta \in [0, 2\pi)$$

Wavefunction:

$$\Psi(x) \propto e^{i\phi(x)} = e^{i\theta(x)/2}$$

Under a full 2π rotation:

$$\oint \nabla\theta \cdot d\ell = 2\pi \quad \Rightarrow \quad \Psi(x) \to -\Psi(x)$$

Spin-$\frac{1}{2}$ sign inversion confirmed.

12.2 Coherence Spinor Construction

Local coherence spinor:

$$\Psi(x) = \begin{pmatrix} \phi_1(x) \\ \phi_2(x) \end{pmatrix}$$

rotates under coherence-induced SU(2)-like transformations:

$$\Psi(x) \to e^{i\vec{\alpha}(x)\cdot\vec{\sigma}/2}\Psi(x)$$

12.3 Angular Momentum Quantization

Quantized angular momentum from coherence flow:

$$S_k = \frac{1}{2}\int d^3x\, \epsilon_{ijk}\rho(x)\left(x^i\partial_j\theta(x) - x^j\partial_i\theta(x)\right)$$

13 Coherence Triplets and Quark Behavior from Cone Geometry

13.1 Fractional Charge from Phase Winding

Coherence winding:

$$Q_a = \frac{1}{2\pi}\oint \nabla\theta_a(x)\cdot d\ell = \frac{n_a}{k_a} \quad (n_a \in \mathbb{Z}, k_a \in \mathbb{Z}^+)$$

allowing fractional charges $\pm\frac{1}{3}$, $\pm\frac{2}{3}$, etc.

13.2 Color Neutrality Constraint

Color singlet condition:

$$\Psi_{\text{color}}(x) = \sum_{a=1}^{3}\vec{C}_a(x) = 0$$

ensures color confinement and singlet formation.

13.3 Confinement Potential from Coherence Resistance

Interaction resistance:

$$R_{ab}(r) = \int_0^r (1 - \chi_a(x))\, dx$$

leading to confinement energy:

$$V_{ab}(r) \propto R_{ab}(r) \quad \Rightarrow \quad V(r) \to \infty \quad \text{as} \quad \chi \to 0$$

13.4 Gluon-Like Field Structure

Effective gluon field strength tensor:

$$F^{ab}_{\mu\nu}(x) = \partial_\mu C^a_\nu(x) - \partial_\nu C^a_\mu(x) + f^{abc}(x)C^b_\mu(x)C^c_\nu(x)$$

with structure functions:

$$f^{abc}(x) \propto \epsilon^{\mu\nu}\partial_\mu\chi^b(x)\partial_\nu\chi^c(x)$$

14 Gluon Field Dynamics from Coherence Curvature

14.1 Gluon Field Definition

Gluon field deviation:

$$G^a_\mu(x) = C^a_\mu(x) - \partial_\mu \phi_a(x)$$

14.2 Gluon Field Evolution Equation

Generalized Yang-Mills-like evolution:

$$\nabla_\mu F^{ab}_{\mu\nu}(x) + f^{abc}(x) G^c_\mu(x) F^{bd}_{\mu\nu}(x) = J^b_\nu(x)$$

where:

$$J^a_\nu(x) = \phi_b(x) \partial_\nu \phi_c(x) f^{abc}(x)$$

14.3 Dynamic Feedback and Gluon Self-Interaction

Gluon self-coupling arises naturally through curvature of coherence fields.