Ratioque v3.7: Mathematical Formalism

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1 Variable Definitions

The Ratioque model treats financial markets as living systems defined by the following state variables.

$N_{\textbf{base}}$	**Base Lattice Constant.** Defined as 720 (order of the symmetric group S_6). Represents the system's resting structural complexity.
ϕ	**Harmonic Scalar.** The Golden Ratio ($1.618\ldots$), governing holographic targets.
σ_t	**Volatility.** The energy input, calculated as the rolling standard deviation of log-returns.
$\mathcal{G}(\sigma)$	**Gauge Potential.** The scalar field coupling volatility to geometric expansion.
$N_{\textbf{inst}}(t)$	**Instantaneous Lattice.** The theoretical size of the habitat if the system had zero memory.
$N_{\textbf{eff}}(t)$	**Effective Lattice.** The realized, path-dependent habitat size accounting for trauma memory.
$\mathcal{S}(t)$	**Vernier Shear.** A topological metric measuring the phase misalignment between memory (N_{eff}) and reality (N_{inst}).
$\mathcal{T}(t)$	**Structural Tension.** A composite measure of stress on the lattice.
$\mathcal{A}(t)$	**Nervous Agitation.** High-frequency intraday arousal, independent of structure.

2 Core Equations

2.1 1. Gauge Potential & Expansion

Volatility performs work on the lattice, creating the *Instantaneous Lattice* N_{inst}.

$$\mathcal{G}(\sigma_t) = \ln(1 + \kappa \cdot \sigma_t) \tag{1}$$

$$N_{\text{inst}}(t) = N_{\text{base}} \cdot \exp(\mathcal{G}(\sigma_t)) \tag{2}$$

Parameter $\kappa = 2.0$ represents Gauge Stiffness.

2.2 2. Asymmetric Trauma Hysteresis

The *Effective Lattice* N_{eff} expands instantly but contracts logarithmically (healing).

$$N_{\text{eff}}(t) = \begin{cases} N_{\text{inst}}(t) & \text{if } N_{\text{inst}}(t) > N_{\text{eff}}(t-1) \\ N_{\text{inst}}(t) + [N_{\text{eff}}(t-1) - N_{\text{inst}}(t)] \cdot e^{-\lambda_t} & \text{if } N_{\text{inst}}(t) \leq N_{\text{eff}}(t-1) \end{cases} \tag{3}$$

2.3 3. Adaptive Decay Rate

Healing speed λ_t inversely correlates with shock severity (Z-score of volatility).

$$\lambda_t = \frac{\ln(2)}{\tau_{base} + \alpha \cdot \max(0, Z_{\sigma_t})} \tag{4}$$

2.4 4. Topological Shear (Vernier)

The phase delta between memory and reality defines the Regime.

$$\mathcal{S}(t) = \sin\left(\frac{2\pi(N_{\text{eff}}(t) - N_{\text{inst}}(t))}{N_{\text{base}}}\right) \tag{5}$$