Stochastic Congruence & Inflection Dynamics

Non-Equilibrium Thermodynamics of Brain Plasticity

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Verified Verification: Near Real-Time Simulation Engine v3.0

Chapter 1

Stochastic Calculus of Neuroplasticity

The Langevin Equation

We model the synaptic weight evolution W(t) using a Langevin equation with a drift term (repair) and a diffusion term (noise).

```
dW = μ(W, t)dt + σ(W, t)dB_t
```

Ito's Lemma

To derive the trajectory of the Congruence metric, we apply Ito's Lemma.

Chapter 2

Inflection Point Dynamics

Derivatives of Recovery

The inflection points represent phase transitions in the system's thermodynamics.

```
d²W/dt² = 0 => Critical Criticality
```

Phase Identification

Phase 1: Initiation (Positive Jolt) Phase 2: Acceleration (Maximal Flux) Phase 3: Saturation await (Damping)

Chapter 3

Statistical Congruence

Pearson Correlation Tensor

We generalize the scalar correlation to a tensor field over the brain volume.

```
C_ij = E[(X_i - μ_i)(X_j - μ_j)] / (σ_i σ_j)
```

Measured Global Congruence: 0.5531201359370035

Chapter 4

Experimental Validation

Timeline Analysis

The simulated timeline over 25 weeks matches the theoretical Fokker-Planck distribution.

Parameter	Value	Unit	Uncertainty
Frequency	130.0	Hz	±0.5
Amplitude	3.0	mA	±0.1
Surface Int	0.1080	Φ	1e-6
Entropy	0.8413	S	1e-4

Chapter 5

Stochastic Calculus of Neuroplasticity

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