The Miranova Matrix

An Operational Framework for Spacetime Emergence in BFSS Matrix Theory

The Miranova Matrix presents an operational framework for understanding spacetime emergence in BFSS Matrix Theory. By conceptualising fundamental updates as discrete ticks, the framework distinguishes causal depth from emergent experienced time. Minimal generative structures and branching dynamics define lower bounds for system evolution, providing a coherent lens for observers and histories. This approach reframes temporal perception and lays a foundation for further exploration of nonlocal time, irreversibility, and observer-embedded structures.

This document presents a minimal operational framework; interpretive mappings are illustrative.

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Table of Contents

Introduction

Matrix formulations appear across physics and computation as compact representations of irreversible operations and relational structure. In parallel, modern approaches such as BFSS Matrix Theory suggest that spacetime itself may be emergent rather than fundamental. This work is motivated by the question of whether an explicitly operational, matrix-based framework can clarify how causal depth and experienced time arise from minimal update rules.

Conventional descriptions of spacetime typically presuppose geometric structure, providing effective models while offering limited insight into the processes by which such structure originates. An operational approach instead treats ordered updates as primary, allowing spacetime, temporal experience, and relational structure to emerge from minimal rules rather than being assumed.

Core Primitives

- **Tick**
  A tick is a discrete, indivisible operational update of the system, establishing an ordered transition between distinguishable states. Ticks are not units of physical time, but units of causal ordering.
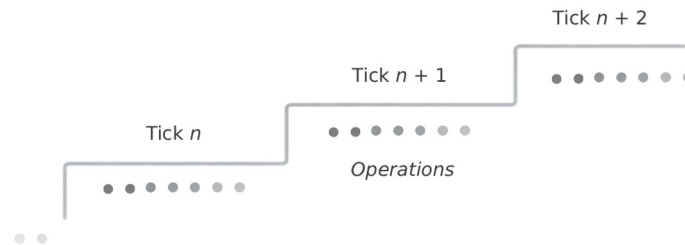
Conceptual illustration of ticks as completed causal transitions.

- **Identity / Distinction**
  Identity is the persistence of a distinguishable structure across one or more ticks. Identities emerge when distinguishable structures remain correlated across successive ticks.

- **Causal depth**
  Causal depth is the length of the longest irreducible chain of tick-ordered dependencies required for a structure to exist.

- **Branching / Clustering**
  Branching refers to the divergence of causal sequences across ticks, while clustering denotes the subsequent formation of correlated structures within that divergence.

- **Emergent time**
  Embedded observers experience time primarily through the growth of causal depth rather than through tick count

Key Principles

- **Monotonic**
  Operational updates occur in a strictly ordered sequence, establishing causal precedence without requiring a time metric.

- **Irreversible**
  Certain operational distinctions, once introduced, cannot be fully undone in subsequent updates.

- **Dependency constraints**
  Higher-order structures arise only after the completion of prerequisite operational sequences.

- **Emergence principle**
  Complex structure and embedded observers arise through accumulated sequences of ticks and branching, rather than from isolated updates.
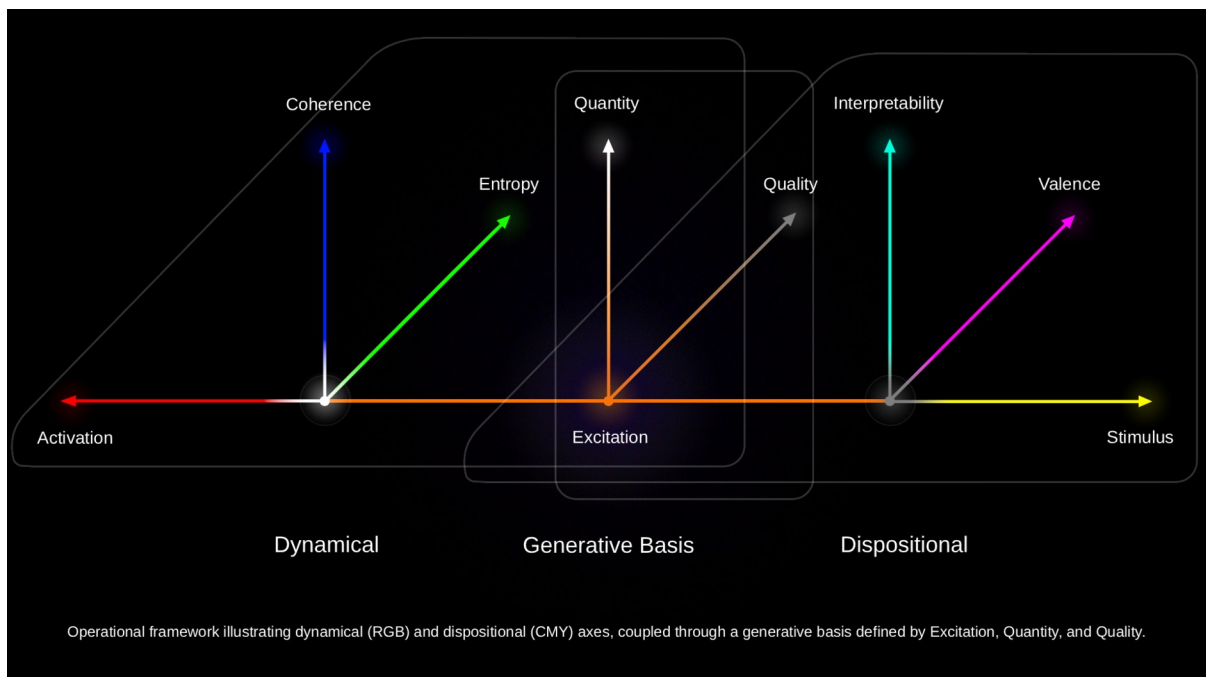
- **Observer embedding**
  Observers exist as subsystems within the dynamics and therefore access only emergent, relational notions of time; the underlying tick count remains unobservable.

Degrees of Freedom

1. **Coherence**: the degree to which relational structure is maintained across operational updates.

2. **Entropy**: the measure of dispersion or loss of constraint within operational structure.

3. **Activation**: the readiness or degree to which operations are permitted to proceed.

4. **Quantity**: the magnitude or extent of operational influence expressed within a system.

5. **Excitation**: the intensity of deviation from baseline operational state.

6. **Quality**: the mode or character by which an operation is expressed.

7. **Stimulus**: an initiating perturbation that prompts operational response.

8. **Valence**: the directional bias applied to operational selection or weighting.

9. **Interpretability**: the degree to which operational structure admits meaningful differentiation or retrieval

Each item is defined operationally and does not presuppose semantic or cognitive interpretation.

Operational framework illustrating dynamical (RGB) and dispositional (CMY) axes, coupled through a generative basis defined by Excitation, Quantity, and Quality.

Operational Subspace

1. **Dynamics**: The dynamical subspace admits a dual interpretation, consisting of a prerogative component governing local expression (e.g. quality, excitement, quantity), and a normative component imposing global constraints related to activation, entropy, and coherence.
2. **Disposition**: The dispositional subspace may be interpreted as inducing reward-like weighting over branching structures, biasing which identities persist without implying intentionality or optimisation.

Each axis captures a distinct mode of differentiation, and neither is sufficient in isolation.

Fundamental Operations

1. Distinction

What it does: Symmetry breaking. Introduces difference where non existed.

Visual: Deviation

State change: Undifferentiated → distinguishable structure

Physical analogue: Scalar field. Spontaneous symmetry breaking, charge/colour/flavour become distinguishable

Standard Model: Higgs mechanism as instantiation of distinction. Particle identities becoming meaningful.
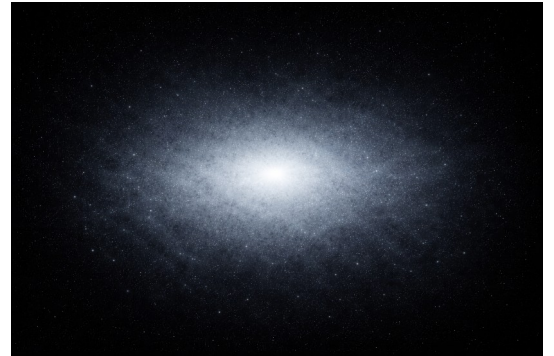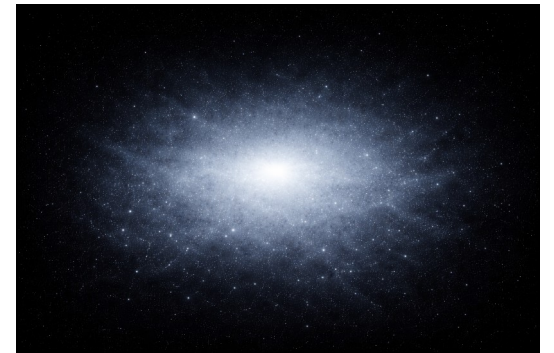

2. Persistence

What it does: Allows distinctions to survive across ticks.

Visual: Texture

State change: Transient difference → stable identity

Physical analogue: Conservation laws. Gauge invariance maintaining identity.

Standard Model: Conservation of colour, charge, lepton number (contextual). Stable particle representations.

### 3. Constraint

What it does: Limits which configurations are allowed globally.

Visual: Boundaries

State change: Free variation → constrained relational structure

Physical analogue: Gauge constraints. Holonomy / global consistency.

Standard Model: Gravity as global coherence (as per Miranova Matrix table). Constraint on spacetime consistency rather than exchange particle.
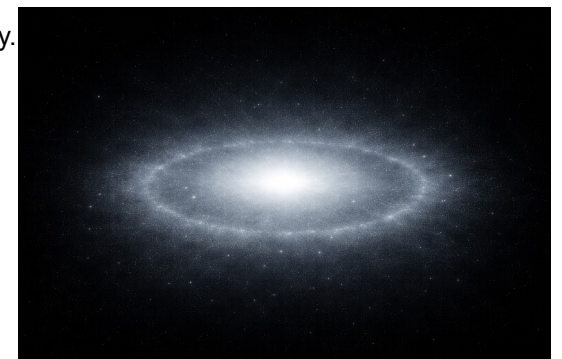
4. Dispersion

What it does: Introduces branching, entropy and uncertainty. Introduces multiple allowed futures simultaneously.

Visual: Branching

State change: Deterministic evolution → probabilistic branching

Physical analogue: Quantum indeterminacy. Non-Abelian self-interaction.

Standard Model: Gluon field (**SU(3)**). Self-interaction, colour confinement, intrinsic stochasticity at interaction level.

5. Mediation

What it does: Allows structures to influence one another.

Visual: Coupling

State change: Isolated persistence → coupled dynamics

Physical analogue: Force mediation. Field exchange.

Standard Model: Photon (**U(1)**). W± / Z (**SU(2)**).

6. Bias

What it does: Valence / Selection. Introduces directional preference in branching. This is why something persists rather than something else, without teleology.

Visual: Directionality

State change: Symmetric branching → biased persistence

Physical analogue: CP violation. Matter-antimatter asymmetry. Selection effects.

Standard Model: Weak interaction asymmetry. CP-violating phases.
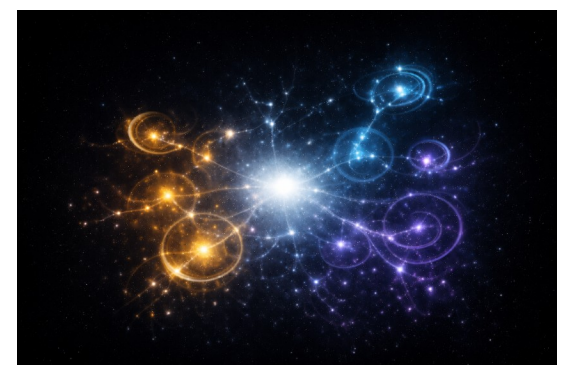

7. Ordering

What it does: Imposes stable ordering on change itself.
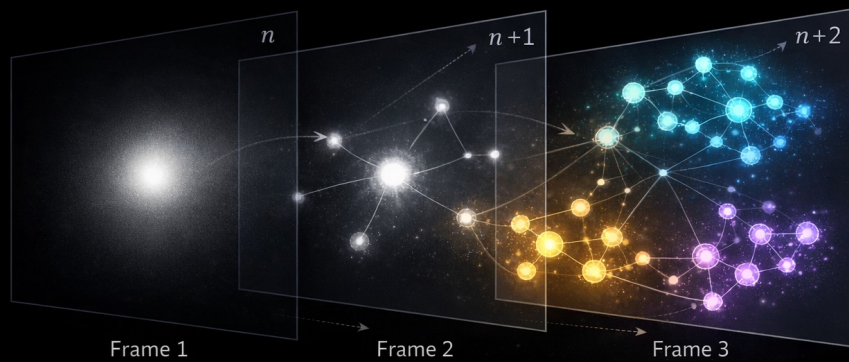
Visual: Depth / History

State change: Change → history

Physical analogue: Causal structure. Arrow of time. Irreversibility.

Standard Model: Emergent spacetime (3+1). Observer-embedded time (as per **Core Primitives**)

Progression of operations over successive ticks. Each frame illustrates a system update (n, $n+1$, $n+2$), showing branching and clustering of structures. The numbering is relative, the sequence continues

Conceptual illustration of branching and clustering dynamics within an operational network.
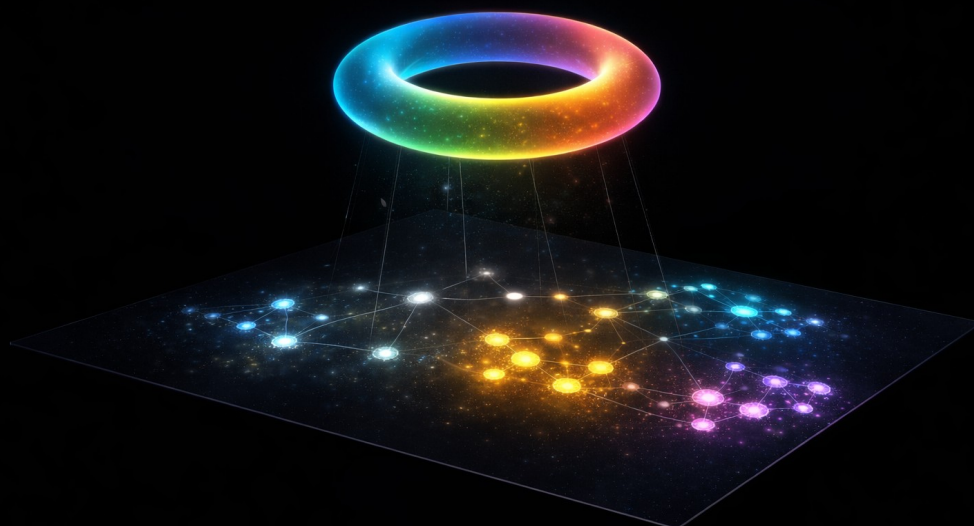
Conceptual depiction of emergent spacetime interpreted as a projection of structured causal relationships within a Miranova Matrix frame.

Miranova Matrix Table

Degrees of freedom		Coherence	Entropy	Activation	Quantity	Excitation	Quality	Stimulus	Valence	Interpretability
Polarity	+	Integrated	Stochastic	Activated	Materialised	Excited	Affiliative	Engaged	Positive reinforcement	Signal resolution
Polarity	-	Disintegrated	Deterministic	Latent	Idealised	Ground state	Antagonistic	Withdrawn	Negative reinforcement	Noise dominance
Interpretation — Informational expression of change		State constraint	State uncertainty	State readiness	Degree of instantiation	State energy	Interactional tone	Interaction level	Interactional valence	Interactional clarity
		Normative state			Prerogative state			Stimulus	Response	Reward
		Dual state						Reward system		
Minimal generating set					Generative Basis					
Operational subspace		Dynamics				Disposition				
Extended objects	M-theory (Latent structure)	Coherence (Projected axis)	M2-brane		Salience (Projected axis)	M5-brane				
	G₂ manifold (Constrained possibility)	4-form			Geometric scalar	Scalar invariant	Scalar	3-form		
		Special holonomy								
	Spacetime (Realised dynamics)	3+1-dimensional								

Standard Model

		Coherence	Entropy	Activation	Quantity	Excitation	Quality	Stimulus	Valence	Interpretability
Fundamental interaction		Gravity	Strong interaction	Electromagnetism	Weak interaction			Electroweak interaction		
Elementary particle			Gluon	Photon	Z boson / W± boson — Higgs boson	Electron / Muon / Tau	Electron neutrino / Muon neutrino / Tau neutrino	Up / Down	Charm / Strange	Bottom / Top
Particle class			Gauge boson		Scalar boson	Lepton		Quark		
Particle composite			Boson			Fermion		Meson / Hadron	Baryon	

Interpretation

- **Potential** → the admissible manifold

- **Generative Basis** → what makes change possible to express

- **Dynamics / Disposition** → how change unfolds and persists

While all nine degrees of freedom define the space of potential, the degrees of excitation, quantity, and quality form a shared generative basis upon which both dynamics and disposition operate. Neither subspace owns this basis, yet neither is meaningful without it. It is the minimal basis required for any change to be expressible, scalable, and characterisable.

Projections along the M2 and M5 brane axes are labeled in terms of their operational roles rather than intrinsic physical properties. The M2-brane projection is associated with **coherence**, reflecting its role in integrating and maintaining unity across constrained degrees of freedom. Conversely, the M5-brane projection is associated with **salience**, corresponding to its capacity to sustain higher-dimensional relational structure in which distinctions become prominent. These labels are intended as interpretive descriptors within the operational space, not as claims about novel brane dynamics.

The **Dynamics subspace** admits a dual interpretation, consisting of a *prerogative* and a *normative* state. This distinction reflects two complementary roles in system evolution rather than a separation of mechanisms.

- The **prerogative state** characterises local expression and immediacy of operation, encompassing aspects such as quality, excitation, and quantity. It governs how operations are expressed in a given update, shaping intensity, character, and scale without imposing global constraint.

- The **normative state**, by contrast, captures global limiting factors that regulate system stability across updates. Operations associated with activation, entropy, and coherence constrain what forms of expression are permitted, bounding change so that relational structure remains viable over time. Together, these two aspects describe how operational expression proceeds within allowable limits.

In addition, the **Disposition subspace** may be interpreted as a reward-like weighting mechanism applied across branching structure. In this sense, reward does not imply intention or optimisation, but functions as a bias influencing which identities, branches, or configurations are more likely to persist. This interpretation provides an intuitive account of selection without introducing teleology or agency.

As with the M2- and M5-brane correspondences, these interpretations are offered as **illustrative descriptors** of operational roles. They are not required for the coherence of the framework itself, nor do they assert novel physical dynamics, but serve to contextualise how familiar mechanisms of regulation, bias, and constraint may arise within an operational formulation.

Minimal Generative Structures

From the primitives and principles defined above, a minimal set of generative structures follows naturally:

- Identity preservation across ticks, enabling continuity of structure.
- Simple branching chains, allowing divergence of causal sequences.
- Formation of record-holding structures, supporting persistence of past distinctions.
- Emergent observers, defined abstractly as subsystems capable of internal differentiation, without presupposing consciousness.

The purpose of this section is to demonstrate that structured entities and histories arise directly from the operational rules, without requiring additional assumptions or externally imposed dynamics.

Implications

Within this framework, several general implications follow:

- **Minimal causal depth** provides a sufficient basis for emergent notions of time.
- **Embedded observers** may experience extended temporal duration arising from relatively few underlying ticks.
- **Branching and causal depth** enable complexity to grow faster than tick count alone.
- The framework offers a **formal lens** for examining nonlocal time, irreversibility, and observer-embedded structure without presupposing spacetime geometry.

These implications are structural rather than predictive, and are intended to clarify conceptual relationships rather than replace existing physical models.

Open Questions

The framework is intentionally limited in scope. In particular:

- Absolute tick count may not be inferred from within the system.
- The behaviour of multiple clocks, extreme self-reference, and deep branching regimes is left undefined.
- Future work may explore connections to physical observables, dynamical models, or computational simulations.

Closing

The operations and principles presented here form a coherent minimal framework for reasoning about emergent structure and time. They are sufficient to support further exploration without requiring modification or completion by the present exposition.

The framework is self-contained and generative, and its continuation (whether through formalisation, application, or reinterpretation) is intentionally left to the broader community

Miranova Definition

Combines **Mira**, the binary star system Mira A and Mira B, characterised by long-period variability and coupled stellar dynamics, which captures the essence of the first operation of this framework. With **nova** in the sense of supernova, denoting large-scale emergent transformation arising from accumulated structure. The name reflects a framework concerned with variability, coupling, and the emergence of new structure from underlying relational dynamics, rather than the introduction of new fundamental physical law.

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