Self Aware Networks Theory– A Response to Konrad Kording addressing the paper “Toward a science of prospective learning” https://www.cell.com/neuron/abstract/S0896-6273(25)00857-8

**Subject: The Physical Mechanism of Prospective Learning: Phase Wave Differentials and Thermodynamic Dissipation**

**1. The Problem: The "Missing Link" in Prospective Learning** Konrad Kording’s paper correctly identifies that current AI fails because it is retrospective—it learns a static distribution from the past ($P_t \equiv P$). To learn prospectively, an agent must model the dynamics of how the world evolves over time ($P_t \rightarrow P_{t+1}$). The system needs a physical mechanism that doesn't just encode "what is" (static state) but "what is coming next" (trajectory).

**2. The Solution: Phase Wave Differentials & Hybrid Computation** My work in *Self Aware Networks* and *Building Sentient Beings* provides this missing mechanism. I argue that the fundamental unit of information is not a spike (a point), but a **Phase Wave Differential** (a relation over time).

- **Hybrid Discrete-Continuous Computation:** In my response to Milinkovic & Aru, I defined "Biological Computation" specifically as hybrid. Current AI treats time as discrete steps. My framework posits that information is encoded in the **spatiotemporal coincidence**—a discrete event (spike) embedded within a continuous analog oscillation. This allows the system to physically encode the *trajectory* (the continuous wave slope) inside the *state* (the discrete spike).
- **Why this is Prospective:** A "differential" is inherently a measure of change. By encoding information in the phase offset (the difference in timing between two waves), the brain effectively captures the derivative of the signal—its rate and direction of change.
- **The "Scanner" Mechanism (NAPOT):** My theory uses traveling waves to physically "scan" neural arrays. This is the physical implementation of "looking forward." The wave projects a prediction (the "tonic" canvas) forward in space-time, converting temporal predictions into spatial patterns.
- **The "Error" Signal:** When actual sensory input arrives, it collides with this projected wave. The mismatch—the Phase Wave Differential—is the prediction error.

**3. The "Engine": Micah’s New Law of Thermodynamics** Kording asks *how* the system updates to correct this error. "Micah’s New Law" explains the physics of that update.

- **The Law:** Systems move toward equilibrium by dissipating gradients through iterative local interactions.
- **The Application:** The "Phase Wave Differential" is the gradient. The brain is thermodynamically driven to dissipate this differential.
- **The Cost Function (Metabolic Efficiency):** Why does the system care? In my model, "Prediction Error" is physically instantiated as **Phase Frustration** (desynchrony). Desynchronized systems waste energy. Therefore, the drive to "predict the future" is actually a thermodynamic drive to minimize metabolic cost by achieving global

phase-locking (Resonance). Prospective learning is not a computational choice; it is a thermodynamic imperative to minimize phase frustration.

**4. From Metaphor to Formal Mechanism** This moves the theory from an intuitive metaphor to a rigorous physics-based argument, supported by the following pillars from my "SIT Corpus":

- **The Physics Bridge (From "Micah's New Law"):** How does a quantum fluctuation drive a macroscopic thought? It is a cascade of difference dissipation. Just as the Kuramoto Model describes oscillators reducing phase differences ($\theta_j - \theta_i$) , the brain functions as a thermodynamic engine where the property being equalized is Phase. A sensory input (like a photon) introduces a high-energy perturbation (differential); the nervous system must propagate specific neural firing sequences to dissipate that differential, realigning the global state.
- **The Information Unit (From "Coincidence as a Bit"):** The fundamental unit is the **Coincidence**. A single spike is noise; two spikes arriving at once represent a Phase Lock. My work evolves this: discrete coincidences are snapshots of continuous coherence. Large-scale coherence patterns are cascades of coordinated micro-coincidences, solving the "Binding Problem" mechanically without requiring a central processor.
- **Robustness via Reset Amplification (From "SAN Scaling"):** You might ask how subtle phase differences survive biological noise. My scaling analysis shows that a single micro-event can trigger an **Inhibitory Reset**—a "shush" that forces a population of neurons to restart their firing cycle simultaneously. This creates **Reset Amplification**: it converts a microscopic timing difference into a macroscopic population phase-lock, scaling the signal from noise (proportional to $\sqrt{N}$) to coherent signal (proportional to N). This is how the brain stabilizes a "prospective" trajectory against thermal noise.
- **The Implementation (From "SAN" & "MASI"):** The MASI sensor proves that physical synchrony is unnecessary if you have *Computational Synchrony*. Cortical columns can act as independent agents capturing raw data with phase offsets. Inhibitory interneurons act as the "Solver," suppressing out-of-phase signals and amplifying in-phase signals to create a "Synthetic Aperture" of the mind—a unified scene created from messy, independent sensors.
- **The Architecture (From "Building Sentient Beings"):** The memory structure is a **Totality**—an adaptive world model. This uses "Activative Memory," where knowledge is active or inactive based on its oscillatory resonance with the current context. The "Self" is the Global Standing Wave that emerges when these internal ensembles synchronize.

**5. Summary** My work characterizes traveling waves as the mechanism that scans and integrates neural activity to construct conscious experience.

- **The Predictor:** Traveling Waves physically 'scan' future distributions (converting time to space).
- **The Error:** The difference between the 'predicted' wave and the 'actual' sensory wave creates a Phase Wave Differential.

- **The Rule:** The system must realign its internal oscillations to dissipate this differential, minimizing metabolic cost.

This is prospective learning: a physical system that constantly updates its trajectory to minimize the phase-error of the future.

**Relevant documents:**

Self Aware Networks
https://zenodo.org/records/16922401

Coincidence as a Bit of Information
https://zenodo.org/records/16922510

Micah's New Law of Thermodynamics
https://zenodo.org/records/16922506

Building Sentient Beings
https://zenodo.org/records/17961966

Self Aware Networks Theory – A Response to Milinkovic & Aru on Biological Computation and Conscious.pdf
https://github.com/v5ma/selfawarenetworks/blob/main/guide/Self%20Aware%20Networks%20Theory%20%E2%80%93%20A%20Response%20to%20Milinkovic%20%26%20Aru%20on%20Biological%20Computation%20and%20Conscious.pdf

SAN Scaling
https://github.com/v5ma/selfawarenetworks/blob/main/guide/SAN%20Scaling.pdf

MASI reference
https://today.uconn.edu/2025/12/new-image-sensor-breaks-optical-limits/#:~:text=In%20radio%20astronomy%2C%20this%20is,and%20phase%20(color)%20information.