Moiré Interference as the Computational Primitive of Field-Based Information Integration:
Connecting the Deerskin Architecture to McFadden's cemi Field Theory

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Abstract

McFadden (2020) argued that consciousness requires spatially integrated information—information that exists simultaneously at every point in a field, rather than being integrated temporally through causal chains. He proposed that the brain's endogenous electromagnetic (EM) field provides this spatial integration, forming the physical substrate of conscious experience (the cemi field theory). However, he did not specify the computational primitives by which such field-based processing operates. We propose that Moiré interference—the pattern that emerges when two geometric structures overlap—constitutes this missing primitive. We describe the Deerskin architecture, a bio-holographic computational framework in which neurons are modelled as topological surfaces, demonstrating that: (1) Takens dendrites achieve 87.4% sequence classification accuracy with zero learned parameters; (2) an adaptive closed-loop system self-organizes its temporal memory depth from 50% chance to 92% accuracy via homeostatic frustration; and (3) field-mediated ephaptic coupling synchronizes 50 spatially distributed agents into a macroscopic standing wave without synaptic connections.

1. Introduction: The Missing Primitive in cemi Field Theory

The binding problem asks how the brain integrates information from spatially and temporally distributed neural processes. McFadden (2020) highlighted that conventional logic gates integrate inputs only in time, lacking a single physical state that holds integrated information. Force fields, however, integrate information in space: at every point in the field, the complete superposition of all source contributions exists simultaneously.

While McFadden demonstrated that overlapping EM fields can implement logic gates (an "algorithm in space"), the precise computational theory remained unspecified. We propose that Moiré interference is this primitive. When a spatial field overlaps with a neuron's physical internal geometry (a receptor mosaic), the resulting interference pattern contains information present in neither alone.

2. The Deerskin Architecture: Empirical Results

To test Moiré computation, we implemented the Deerskin architecture across three escalating scales of complexity.

2.1 The Takens Dendrite (Zero-Parameter Sequence Decoding)

The foundational component replaces standard dot-product attention with a biological Takens delay-line embedding. A 1D scalar signal is expanded into a high-dimensional geometric trajectory, which is then filtered through a spatial Receptor Mosaic physically shaped to match a target frequency's phase-space geometry (e.g., 40 Hz Gamma).

Parameters: n_taps = 16, τ = 4 (world buffer delay), target_freq = 40.0 Hz, f_s = 1000.0 Hz.

Results: A bank of Takens dendrites was tested on a sequence decoding task with overlapping tokens (40 Hz target vs. 65 Hz distractor) embedded in additive noise (σ = 0.15 to 0.20). The system achieved 87.4% accuracy with zero learned parameters and zero training samples, utilizing pure topological matching to filter out the 65 Hz distractor dynamically.

(Figure 1: Phase-space plots from this experiment show the delay-embedded trajectory (X_t vs $X_{t-2\tau}$) resolving into a strange attractor, which the Theta Soma selectively attends to via a rigid pacemaker gate shifting by exactly π radians.)

2.2 Closed-Loop Self-Organization of Temporal Reach

To demonstrate temporal context integration, we placed the Takens neuron into a closed recurrent loop (Neuron C receiving inputs from Neurons A and B) tasked with temporal context disambiguation.

The Task: A sequence of [Context Token: 50 ms] $\rightarrow$ [Silence Gap: 40 ms] $\rightarrow$ [Ambiguous Token: 50 ms at 40 Hz]. Context tokens were non-harmonic (11 Hz or 61 Hz).

The Mechanism: The neuron utilizes an "Adaptive Self-Buffer." Driven by a homeostatic frustration signal (target context strength = 0.15), the dendrite virtually "elongates" (adds taps) if it cannot reach the context token.

Results: Open Loop (no recurrent): ~50% (chance). Closed Loop Short Buffer (self_taps = 4): ~50%. Closed Loop Oracle (self_taps = 80): ~92%. Closed Loop Adaptive: starting at self_taps = 4, the neuron self-organized to lengths exceeding 80 samples (peaking around 117), achieving ~92% accuracy without gradient descent.

(Figure 2: The accuracy bar chart demonstrates the 42-percentage-point leap entirely attributable to recurrent connectivity, while the buffer growth curve tracks the dendritic branch elongating through the silence gap until homeostasis is found.)

2.3 Field-Mediated Synchronization: The Pyramidal Chorus

To test pure spatial integration, we simulated 50 spatially distributed Pyramidal Agents arranged on a 1D cortical sheet. Crucially, no synaptic connections existed between them.

The Medium: Agents were coupled entirely through an Ephaptic Distance Matrix simulating electromagnetic drop-off through tissue ($e^{-distance^2/10.0}$).

The Perturbation: A sharp environmental trauma (impact = 1.0) was introduced exclusively to the centre epicentre (Neurons 20–30) between time ticks 50 and 70.

Results: The localized trauma created a Moiré gradient disturbance. Despite lacking physical wires, the un-traumatized flanking neurons felt the local magnetic field shift via the $O(N^2)$ distance matrix. They dynamically adjusted their internal geometric phase (θ) to match the global field, generating a propagating healing wave that pulled the entire 50-agent sheet back into a phase-locked "Chorus."

(Figure 3: The Macroscopic EEG Wave dashboard shows the Local Field Potential (cyan wave) organizing the individual Pyramidal Neurons (magenta points). Below it, the 2D Moiré tissue monitors for Left Flank, Epicentre, and Right Flank show identical synchronized Moiré patterns once homeostasis is restored.)

3. Moiré Interference as the Dynamic Laplacian

The Pyramidal Chorus demonstrates exactly how the cemi field integrates information. The operational chain is as follows:

(1) Firing neurons perturb the local EM field with a geometric signature dictated by their physical receptor mosaic.

(2) The extracellular field superimposes these signatures via inverse-square decay.

(3) Receiving neurons compute the Moiré interference between this macroscopic field pattern and their own internal geometry.

(4) Constructive interference produces resonance (firing), which updates the field, closing the loop.

The "answer" to any stimulus is the steady-state eigenmode: the geometric wave-state where the field generates the exact firing pattern required to sustain that exact field. This self-consistency condition is McFadden's "algorithm in space" made concrete.

4. Honest Limits and the Critical Prediction

We measured two coherence quantities in the Pyramidal Chorus: (a) scalar phase coherence (Kuramoto order parameter), and (b) geometric Moiré coherence (cross-overlap between neighbouring mosaics).

In our current 1D simulation, these correlate at r = 0.94–0.98. The divergence is measurable but small (~5%), peaking at 0.055 when natural frequency variance is introduced. This is because our current agents are parameterized by a single rotation angle θ.

The Critical Prediction: When scaling to higher-dimensional internal geometries—analogous to the full 3D branching structure and ion channel distributions of biological dendritic trees—geometric coherence and scalar coherence will diverge significantly. In this regime, two neurons might have identical scalar phases but different geometric compatibilities with the field.

Once this divergence is proven, it establishes that field-based Moiré computation is irreducible to standard coupled-oscillator physics, officially requiring a connection on a fibre bundle (a gauge field) to describe how geometry mediates neural compatibility.

This prediction is testable with current technology: record from populations of morphologically characterized neurons, measure both phase coherence and a geometric compatibility index derived from their dendritic morphologies, and test whether these diverge during ephaptic coupling.

5. Implications

5.1 The Inverse Problem

If the steady state is self-consistent—the field generates the firing pattern and vice versa—then observing the field (via EEG/MEG/LFP) provides constraints on the geometry of the medium producing it. In principle, the distribution of receptor geometries can be inferred from field measurements by inverting the self-consistency condition. This is the inverse problem of the Dynamic Laplacian: given the macroscopic standing wave, what microscopic geometric structures are consistent with it?

5.2 For Artificial Intelligence

McFadden (2020) describes the FPGA experiment at the University of Sussex (Thompson et al. 1996) in which an evolutionary algorithm produced a circuit that used EM field coupling between disconnected components—an algorithm in space, evolved accidentally. The Deerskin architecture provides a principled framework for designing such systems intentionally: arrays of geometric resonators coupled through a shared field, where computation emerges from interference rather than wire-mediated signal propagation.

5.3 For Neuroscience

The framework predicts that neurons' contribution to field-based computation depends not only on their firing rate and phase, but on their dendritic morphology—the shape of their "receptor mosaic." This suggests that morphological diversity among neurons in a cortical column is not noise or redundancy, but the functional substrate of Moiré computation. Different geometries compute different things when exposed to the same field.

6. Conclusion

McFadden established that spatially integrated information requires fields, not wires. The Deerskin architecture provides the exact mathematical engine for this field: Moiré interference between macroscopic EM standing waves and microscopic dendritic geometries. It demonstrates that intelligence does not require billions of learned dot-products, but rather a resonant medium with the correct physical topology, shifting phases to find survival homeostasis in the "salty sea" of the brain.

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