Title:

The Chiral Anomaly Is Not an Anomaly: Reinterpreting Quantum Symmetries through Subquantum Oscillatory Physics (NMSI)

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Abstract:

This paper proposes a novel reinterpretation of the chiral anomaly from the perspective of New Subquantum Informational Mechanics (NMSI), a foundational model based on the concept of oscillatory phase–antiphase logic cores within a subquantum informational substrate. We show that anomalous current divergences observed in QFT are not the result of symmetry violations, but resonance instabilities in deep logical coherence systems. The model provides a unified ontological framework in which particles, interactions, and spacetime itself emerge from coherent oscillatory dynamics, offering new insights into quantum anomalies, gauge symmetry, and the unification of physical laws.

Keywords:
Chiral anomaly, axial current, subquantum physics, phase resonance, gauge symmetry, logical oscillation, informational mechanics, pion decay, unification theory

Section 1 – Introduction

The so-called "chiral anomaly" is commonly treated in the Standard Model of particle physics as a mathematically necessary violation of chiral symmetry at the quantum level, despite its conservation at the classical level. This anomaly manifests in processes such as the decay of the neutral pion into two photons, and is considered a hallmark of the deep interplay between gauge symmetries and quantum field theory (QFT). While its computation is well-established via triangle Feynman diagrams and regularization procedures (e.g., Pauli-Villars, dimensional regularization), the physical interpretation remains opaque. What is considered a "broken symmetry" in QFT is, in essence, a label for the failure of certain conserved currents to survive quantization.

In this paper, we propose a reinterpretation of the chiral anomaly from the standpoint of the New Subquantum Informational Mechanics (NMSI), a framework that posits a deeper subquantum layer underpinning physical reality, where information and logical oscillations replace the notion of point particles and field lines. In this model, all physical entities are constituted by phase–antiphase oscillatory cores, stabilized by coherent subquantum logic, not merely energy minimization or gauge invariance.

Unlike conventional QFT, which treats symmetry as a property of Lagrangians, the NMSI approach treats symmetry as an emergent phenomenon from underlying oscillatory phase relations. From this perspective, the so-called "anomaly" is not a violation of symmetry but a transition between stable oscillatory configurations, governed by discrete informational resonance thresholds in the subquantum substrate.

We argue that the decay channels where anomalies appear are in fact resonance-driven reorganizations of oscillatory structures. The divergence of the axial current, in this context, corresponds not to the non-conservation of a classical quantity, but to a realignment of internal oscillatory coherence under high informational stress (such as high-energy interactions).

In the sections that follow, we will:
- Describe the logical structure of NMSI and its assumptions;
- Show how subquantum oscillatory cores reproduce quantum behavior in the low-energy limit;
- Derive mathematical expressions for phase–antiphase coupling and its effect on observable currents;
- Apply the model to the neutral pion decay as a benchmark case;
- Discuss the broader implications of this reinterpretation for gauge symmetries, entanglement, and the unification of interactions.

This work does not aim to discard quantum field theory, but to offer a foundational substrate in which its apparent anomalies become logically coherent outcomes of deeper subquantum structures.

Section 2 – Logical and Oscillatory Structure of the NMSI Model

The NMSI framework is based on the principle that all elementary particles and fields are emergent phenomena arising from coherent oscillatory structures embedded in a subquantum informational substrate. This substrate is not a field in the classical sense, but a logical lattice of phase states, where stable configurations correspond to what we perceive as particles, and transitions between these configurations correspond to interactions.

Each particle is modeled as a central oscillatory core (COC), which consists of a nucleus-like logical center oscillating in antiphase with its surrounding halo structure. This internal phase–antiphase dynamic ensures local stability and defines the particle’s identity, charge, spin and energy signature. The resonance conditions between multiple such cores determine the strength and type of interaction.

We denote the core–halo oscillation by a dynamic pair (φ, -φ), with temporal evolution governed by subquantum coupling laws:

$$\varphi(t) = \varphi_0 \cos(\omega t + \delta), \qquad H(t) = -\varphi_0 \cos(\omega t + \delta)$$

The constructive interference of multiple oscillators of same phase results in mass accumulation or gravitational-type coherence, whereas destructive interference yields phase decoupling — perceived macroscopically as particle decay, annihilation, or tunneling effects.

This framework replaces the traditional field-potential paradigm with a logic-of-resonance paradigm: forces are no longer exchanges of particles, but logical results of interference between oscillatory cores across the subquantum matrix.

Key axioms of NMSI:
1. Phase–Antiphase Duality: Every stable subquantum structure is a superposition of oscillatory pairs with balanced phase.
2. Discrete Informational Quantization: Energy and mass are emergent from the resonance frequency and phase stability.
3. Coherence-Driven Interaction: All known interactions are manifestations of subquantum coherence dynamics.
4. Observer-Dependent Visibility: Interaction is possible only between systems that share partial phase compatibility — a principle generalizing entanglement.

In the next section, we will formalize the mathematical conditions under which axial current divergence arises as a resonance instability in a coherent oscillatory system.

Section 3 – Mathematical Derivation of Axial Current Divergence from Oscillatory Instability

To establish a connection between the classical divergence of the axial current and a subquantum oscillatory instability, we begin with a formal description of the axial current J_5^μ:

$$J_5^\mu = \bar{\psi}\gamma^\mu\gamma^5\psi$$

In QFT, the divergence $\partial_\mu J_5^\mu$ is classically zero but acquires a nonzero value at the quantum level due to the anomaly:

$$\partial_\mu J_5^\mu = (e^2 / 16\pi^2)\, \varepsilon^{\mu\nu\rho\sigma} F_{\mu\nu} F_{\rho\sigma}$$

Within the NMSI framework, we reinterpret this divergence as the breakdown of internal phase–antiphase resonance coherence under external energetic perturbation. Let us define the local coherence function C(t) for a particle as:

$C(t) = \int_V \varphi(t,x) \cdot H(t,x)\, dx$

Where φ and H are the phase and antiphase oscillatory fields inside the particle's core–halo structure. A perfectly stable configuration satisfies:

$dC/dt = 0$

But under strong perturbations (such as intense gauge field interaction $F_{\mu\nu}$), we have:

$dC/dt = -\alpha \cdot F_{\mu\nu}F^{\mu\nu} + \beta \cdot \nabla^2\varphi$

Where α, β are coherence decay and dispersive coefficients specific to the subquantum medium. The resonance threshold is crossed when $C(t) \to 0$, triggering a spontaneous reconfiguration of oscillatory states. This manifests macroscopically as anomalous divergence.

Hence:

$\partial_\mu J_5^\mu \sim dC/dt \,|_{(resonance)}$

This formulation links the anomaly to a quantifiable instability in phase logic coherence, rather than to a breakdown in symmetry. It opens the path to experimentally modeling the anomaly through high-precision coherence phase decay in engineered subquantum resonator arrays.

In the next section, we will apply this framework concretely to the pion decay process $\pi^0 \to 2\gamma$, comparing the standard amplitude derivation with the NMSI-based resonance interpretation.

Section 4 – Application: Neutral Pion Decay ($\pi^0 \to 2\gamma$) in the NMSI Framework

The neutral pion decay into two photons has long been regarded as a key empirical manifestation of the chiral anomaly. In conventional QFT, the triangle diagram calculation yields a decay amplitude that directly depends on the anomalous divergence of the axial current. This result, while predictive, leaves unanswered the fundamental question: what physically triggers this decay?

From the NMSI perspective, the π^0 meson is modeled as a temporary oscillatory resonance configuration formed by quark–antiquark phase cores coupled within a shared halo. The system is stabilized by a coherent phase–antiphase interaction:

$\pi^0 = (\varphi_q, -\varphi_{\bar{q}})_{bound}$

When exposed to strong external electromagnetic fluctuations — such as those encountered in high-energy environments — this internal coherence becomes unstable. The neutral pion's core loses subquantum phase alignment, leading to a collapse into two coherent light quanta:

$(\varphi_q, -\varphi_{\bar{q}}) \rightarrow (\varphi_{\gamma}^1, \varphi_{\gamma}^2)$

We define the informational coherence threshold Θ_c as the minimum resonance instability required to induce this decay:

$\Theta = \int_V |\nabla \cdot (\varphi_q + \varphi_{\bar{q}})|^2 \, dx$

Decay occurs when $\Theta \geq \Theta_c$, which corresponds to a measurable disruption in the subquantum core–halo oscillatory structure.

Moreover, the observed amplitude of decay, usually derived via the axial anomaly, now corresponds to the efficiency of phase fragmentation:

$A(\pi^0 \rightarrow 2\gamma) \sim \lim_{\Theta \rightarrow \Theta_c} d^2C/dt^2$

Where C is the coherence function defined previously. This suggests that what QFT observes as an "anomalous" transition is, in fact, a logical fragmentation of an unstable phase resonance.

In this formulation, photons are not simply gauge bosons, but emergent propagating phase solitons—logical outcomes of phase re-alignment, not quantum fields in a vacuum.

This perspective resolves several interpretational inconsistencies:
- The decay is not mediated by virtual particles, but by subquantum decoherence triggers.
- The amplitude depends not on symmetry violation, but on resonance degradation rate.
- The process is logically deterministic, not probabilistically random.

In the next section, we will discuss how these results generalize to gauge symmetries and offer an extended view on the unity between subquantum logic and field theory.

Section 5 – Implications for Gauge Symmetries and Unification of Interactions

The reinterpretation of the chiral anomaly through the NMSI model invites a re-examination of the very concept of gauge symmetry. In conventional quantum field theory, gauge symmetries are imposed as invariances of the Lagrangian under certain local transformations, leading to the introduction of gauge bosons and conserved currents. These symmetries are formal, and their spontaneous or anomalous breaking leads to rich phenomenology, including mass generation and anomaly cancellation constraints.

However, in the NMSI framework, gauge symmetries emerge not as imposed constraints but as logical consequences of phase coherence relations within and among subquantum oscillatory structures. A "symmetry" is nothing more than a stable regime of informational resonance across an ensemble of oscillators. When that resonance becomes unstable — due to internal phase stress, external perturbation, or boundary mismatch — the symmetry appears to "break."

Thus, the Standard Model's gauge groups (SU(3)×SU(2)×U(1)) are interpreted not as fundamental symmetries, but as effective domains of phase–antiphase coherence stability in the subquantum lattice. Each interaction (strong, weak, electromagnetic) reflects a different regime of resonance bandwidth and coupling granularity:

- Electromagnetism arises from phase-aligned coupling in open coherent shells.
- Weak interaction corresponds to partial phase dephasing in mixed halo–core overlap.
- Strong interaction represents deep internal core entanglement with high phase-lock rigidity.

Gravity, as previously addressed, is not a gauge field at all, but a meta-effect of long-range phase coherence across oscillatory cores — a vectorial result of constructive interference.

This model opens new directions for unification:
- The goal is not to embed all forces in a higher symmetry group, but to unify them as logical phases of the same underlying oscillatory substrate.
- Traditional concepts like symmetry breaking, spontaneous generation, or gauge boson exchange become emergent language descriptors of resonance transitions.
- Phenomena like entanglement, teleportation, and non-locality are seen as manifestations of global subquantum phase-locking, not violations of relativity.

Section 6 – Testable Predictions and Experimental Integration of NMSI

For a theory to gain scientific credibility, it must yield predictions that can be verified or falsified by experimental observation. Although the NMSI framework operates on a level deeper than current quantum field theory, its effects cascade upward into measurable macroscopic phenomena. The model's unique emphasis on coherence, resonance, and phase-logic allows it to generate specific, novel predictions that deviate from the expectations of standard quantum theory.

1. Phase-Coherence Decay Signatures in Particle Interactions
The NMSI model predicts that decay events such as ($\pi^0 \rightarrow 2\gamma$) or weak boson emission are not probabilistic but deterministic transitions through resonance thresholds. Therefore, repeated experiments under nearly identical energetic and environmental conditions should reveal subtle, non-random patterns in decay timing, angular distributions, or emitted photon correlations.

2. Subquantum Interference Resonators
By engineering materials with ultra-high phase stability (e.g., superconducting EM cavities, entangled crystal lattices), it may be possible to observe coherence loss thresholds analogous to "anomalies" in particle physics, without invoking QFT field exchange. These experimental platforms could simulate axial divergence through tailored decoherence profiles.

3. High-Precision Recoil Timing in Neutrino–Photon Events
As proposed in Section 1, neutrino arrival time preceding photons from supernovae can be revisited with extreme time-resolution tools. NMSI suggests that photon delay is due to cumulative phase recoil with ambient hydrogen atoms, which should manifest as statistically significant delays in redshifted regions.

4. Artificial Induction of Phase-Triggered Decay
The model implies that a pion, or other metastable mesons, can be externally stimulated to decay not via energy input, but via phase perturbation — for example, applying a subquantum-coherent EM field matching the particle's core frequency could force earlier transition.

5. Gravity as Phase Vector Field
Using sensitive atomic interferometry (e.g., cold atom gravimeters), experiments can test for directionally coherent shifts in phase-resonance gradients when massive coherent objects are moved nearby. These shifts should not align exactly with Newtonian mass-based gravity, but reflect informational phase alignment.

Roadmap Toward Integration:

- Theory Development: Formalize NMSI's subquantum logic as a dynamical system using phase-state differential equations. Introduce invariants of phase coherence.
- Simulation Tools: Build software environments to simulate coupled oscillatory systems

with phase thresholds and evaluate emergent macroscale behavior.
- Collaboration with Quantum Engineers: Interface NMSI logic with superconducting qubit arrays and optical cavity systems to test coherence stressors.
- Hybrid Metrics: Redefine measurement tools in particle physics to include coherence-time, phase-jitter, and logical alignment — beyond energy and momentum.

Ultimately, the NMSI model invites us to see the Universe not as a machine of particles and forces, but as an orchestra of phase-locked oscillations — a logic-infused harmonic structure where structure, interaction, and transformation are governed by rhythm and resonance.

Section 7 – Final Remarks and Ontological Implications

The chiral anomaly, long regarded as a paradoxical yet essential phenomenon in quantum field theory, reveals under the lens of the NMSI model a coherent and intelligible structure. What QFT interprets as a breakdown of symmetry is reframed as a transition between stable and unstable informational resonance states. This reinterpretation does not invalidate existing physics, but enriches it by rooting quantum behavior in a deeper, subquantum domain of oscillatory logic.

By conceptualizing particles as oscillatory phase cores and interactions as emergent coherence dynamics, NMSI provides a new vocabulary to bridge quantum mechanics, field theory, and gravitation. Rather than attempting to quantize gravity or geometrize gauge fields, it offers a unifying substrate where all known forces emerge from a single principle: **the logic of resonance**.

This ontological shift from energy–matter to information–phase coherence has profound philosophical consequences:

- **Reality becomes fundamentally informational**, and structure arises from logical compatibility, not mechanistic causality.
- **Causality itself is redefined**: events occur not linearly, but when oscillatory systems achieve temporary resonance.
- **Time becomes a local rhythm**, not a universal parameter — a property of internal oscillatory cycles.
- **Space becomes relational**, defined by resonance gradients, not fixed coordinates.

In this view, the Universe is not a continuum populated by discrete objects, but a **dynamic matrix of logical oscillations**, where particles, waves, fields, and even observers are manifestations of coherent phase domains.

As with all scientific revolutions, the transition to such a paradigm will require not only technical development, but also a shift in intellectual perspective — from analyzing interactions, to listening for the music of coherence beneath them.

The NMSI model does not seek to dismantle the achievements of quantum field theory, but to illuminate their deeper causes, and in doing so, to offer a pathway toward the long-sought unification of physics: not as a tower of equations, but as a **symphony of logic**.

In this vision, the true unification is not mathematical but ontological: all phenomena, from forces to particles, emerge from the same informational matrix via stable and unstable configurations of oscillatory logic.

In the final section, we will discuss possible testable predictions of this reinterpretation and the roadmap for integrating NMSI with experimental physics.

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