Title

Logical Oscillations and Symmetry Anomalies: Experimental Confirmations Supporting the NMSI Theory

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Abstract

In recent years, a series of high-precision experiments conducted at CERN (ATLAS, CMS, NA61/SHINE), Fermilab, and other international laboratories have revealed quantum anomalies that are difficult to explain within the framework of the Standard Model, but fully integrable within the conceptual architecture of the **New Subquantum Informational Mechanics** (NMSI). These anomalies include: unexpected formation of top–antitop pairs (toponium), breaking of flavor and CP symmetries, quantum entanglement at extreme energies, the chiral anomaly, and the magnetic moment deviation of the muon. This article aims to provide a structured interpretation of these experimental results through the lens of NMSI—a model based on stabilized logical oscillations, informational entanglement, and phase transitions in the subquantum vacuum. Each anomaly is reinterpreted not as a breakdown of known physics but as evidence of a deeper logical structure underpinning matter and interaction fields.

Keywords

NMSI theory, subquantum vacuum, logical oscillations, symmetry anomalies, toponium, CP violation, muon g-2, chiral anomaly, entanglement, Higgs transition states, TQC, logical phase network

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Chapter 1 – Toponium: Unexpected Formation of Top–Antitop Pairs

1.1 Experimental Observations: ATLAS & CMS (2025)

Recent high-precision data from the ATLAS and CMS experiments at CERN, collected during Run-3 of the LHC in 2025, revealed an unexpected resonance-like excess in the production of top–antitop ($t\text{–}\bar{t}$) pairs at a center-of-mass energy corresponding to a cross-section of approximately 8.8 picobarns (pb). This result significantly exceeds the predicted values of the Standard Model (SM), particularly in the region just above the production threshold, where no known resonance was expected.

This anomaly suggests the formation of a quasi-bound state of top and antitop quarks—commonly referred to as toponium—despite theoretical arguments that such a state should be extremely unstable due to the very short lifetime of the top quark (on the order of 5×10^{-25} s), which is thought to decay before any hadronization can occur.

Yet the data implies a stabilization mechanism that allows the $t\text{–}\bar{t}$ system to momentarily resonate in a coherent, intermediate state—possibly hinting at physics beyond the Standard Model.

1.2 Conceptual Dissonance in the Standard Model

According to the Standard Model, the top quark's extremely short decay time should prevent the formation of any top–antitop hadronic resonances. The toponium state, while mathematically allowed in some effective QCD models, is considered practically inaccessible.

Thus, the formation of such a state in high-energy collisions without a viable mechanism for stabilization poses a serious challenge to the completeness of the SM. This has driven both theorists and experimentalists to search for alternate interpretations, including those outside conventional quantum field frameworks.

1.3 The NMSI Interpretation: Toponium as a Logical Oscillatory Node

The New Subquantum Informational Mechanics (NMSI) offers an alternative conceptual framework. Rather than treating quarks as point particles or field excitations only, NMSI models all particles as logical oscillatory systems stabilized by phase interactions within a subquantum informational vacuum.

In this model:

- The top–antitop resonance is interpreted not as a conventional hadronic bound state but as a temporary logical oscillatory node, formed by synchronized phase entanglement between the top and antitop's internal oscillations.

- The extreme energy and coherence present in LHC collisions enable a brief stabilization of this node through phase resonance, despite the short lifetimes involved.

- The resonance appears as a measurable cross-section peak due to this temporary synchronization of oscillatory states—not due to traditional confinement or potential well interactions.

1.4 Mathematical Framing (Preliminary)

While a complete mathematical formulation within NMSI is under development, a qualitative representation would involve:

- Treating each quark as an oscillating logic system with a dominant phase vector:

$\varphi_t(t) = \omega_t t + \delta\varphi$

- The resonance occurs when the differential phase between t and $\bar{t}$ oscillators reaches a harmonic entanglement condition:

$\Delta\varphi_{t\bar{t}}(t) = n\cdot 2\pi$ with $n \in \mathbb{Z}$

where phase matching is maintained for a brief temporal interval τ_res.

- During this interval, the composite system behaves as a coherent oscillatory node, with measurable resonance properties such as decay width, mass peak, and spin correlation.

1.5 Implications

If the toponium anomaly is confirmed and interpreted through the NMSI framework:

- It would suggest that the stability of quark–antiquark systems can be temporarily achieved via phase-coherent resonance, not just via color confinement.

- It would shift the focus from mass–lifetime constraints toward phase dynamics and oscillatory entanglement as stabilizing factors.

- It opens the door for reinterpreting other short-lived resonances (e.g., exotic hadrons) as oscillatory phase nodes, not requiring exotic new particles.

1.6 Conclusion

The unexpected formation of a resonance-like top–antitop state represents a challenge to traditional QCD and the Standard Model. The NMSI interpretation provides a coherent, information-based alternative that explains the observation through phase stabilization of logical oscillations. Rather than invoking new particles or forces, it reveals a deeper structure within quantum processes: the subquantum logic field, where entanglement and phase transitions govern what we perceive as mass, resonance, and decay.

Chapter 2: Quantum Entanglement at Extreme Energies

2.1 Observation Context In recent years, experiments conducted at the Large Hadron Collider (LHC), particularly by the ATLAS Collaboration, have revealed significant quantum correlations between top and antitop quark spins in high-energy collisions. These findings, published in *Nature* (2024), mark a major milestone in probing quantum entanglement at energy scales never before explored.

Unlike low-energy systems (e.g., electron–photon or photon–photon entanglement), top–antitop pairs provide a unique window into the behavior of massive quarks under extreme conditions. Top quarks decay before hadronization, making their spin state accessible in the final decay products. The observed spin correlations in events go beyond classical expectations, exhibiting a coherence pattern indicative of genuine quantum entanglement.

2.2 Standard Interpretation and Limitations Within the Standard Model (SM), spin correlations in top–antitop production are well understood through QCD interactions. However, the observed coherence patterns suggest a deeper structure of information-preserving processes, hinting at an entangled quantum state rather than a statistical mixture. This challenges the assumption that decoherence dominates at high energies.

Moreover, the SM lacks a clear mechanism for preserving quantum entanglement in such unstable and rapidly decaying systems. The persistence of coherence implies a more robust informational structure underlying particle dynamics.

2.3 NMSI Interpretation: Logical Coherence in Oscillatory Networks In the framework of the New Subquantum Informational Mechanics (NMSI), quantum entanglement is not an emergent feature but a fundamental principle. According to NMSI, particles are logical oscillatory nodes within a universal subquantum informational network. The entanglement observed in high-energy events is interpreted as phase synchronization within this network.

Key principles in this interpretation:

- **Entanglement = phase coherence**: In NMSI, entangled particles share a common logical phase across different spatial locations. Their correlated spins result from synchronized oscillations rather than causal interactions.
- **Subquantum connectivity**: The vacuum is not empty but structured by infobits—subquantum logical units—which maintain coherence through oscillatory resonance.
- **Top quark = temporary phase-stabilized oscillator**: The short lifetime of the top quark aligns with its function as a high-frequency oscillator that couples strongly to the informational vacuum, making it ideal for probing entanglement.

2.4 Comparison with Low-Energy Entanglement While traditional entanglement experiments (e.g., Bell tests) focus on photons or electrons, the entanglement offers a radically different context:

- **Energy scale**: Orders of magnitude higher than previous entanglement observations.
- **Decay time**: Top quarks decay within seconds, suggesting that entanglement forms and manifests faster than conventional decoherence models allow.
- **Oscillatory coherence**: NMSI posits that coherence is not erased by decay but redistributed through logical resonance in the vacuum.

2.5 Implications and Future Directions These findings support the view that the vacuum is not a passive background but an active logical medium. Entanglement becomes evidence of a universal phase structure, persistent across energy scales.

Future experiments can test this by:

- Measuring entanglement in even shorter-lived states.
- Correlating entanglement signals with predictions from oscillatory logic models.
- Designing phase-sensitive detectors to identify subquantum resonances.

2.6 Conclusion Quantum entanglement at extreme energies challenges the classical interpretation of coherence decay. The NMSI framework redefines entanglement as intrinsic phase synchronization within a logical oscillatory medium. Top quarks, due to their rapid decay and high mass, act as transient probes into this hidden structure of reality, offering a glimpse into the fundamental architecture of matter.

Chapter 2 has been fully translated, expanded, and structured in English under the title **“Quantum Entanglement at Extreme Energies”**. It's now available in the document named **"Toponium Nmsi"** in the sidebar.

Chapter 3 – Breaking of Isospin and Flavor Symmetry in NA61/SHINE

3.1 Experimental Anomalies in Up/Down Quark Production

Recent results from the NA61/SHINE experiment at CERN have provided compelling data on the production rates of hadrons in proton–nucleus and nucleus–nucleus collisions. One of the most significant anomalies observed was a pronounced deviation in the ratio of up/down quark production, especially in final-state hadrons.

Specifically, measurements indicate that the ratio of produced up-flavored hadrons (such as π^+) to down-flavored hadrons (such as π^-) departs from theoretical predictions with a significance exceeding **4.7σ**. This degree of statistical deviation strongly suggests that the traditional flavor symmetry assumed by the Standard Model (SM) is not preserved in high-energy, high-density environments.

These observations challenge the SM assumption of near-degenerate quark masses (mu ≈ md) and universal couplings within isospin doublets. Instead, they hint at an underlying mechanism that differentiates quark flavors in a context-sensitive manner.

3.2 Theoretical Limitations of the Standard Model

Within the SM, flavor symmetry and isospin symmetry are consequences of the gauge structure and the Higgs mechanism, which introduces small mass differences between quarks. However, these differences are expected to be negligible in high-energy collisions where chiral symmetry is approximately restored.

The unexpected flavor asymmetry in NA61/SHINE cannot be accounted for by current QCD-based models, parton distribution functions, or hadronization models. Furthermore, the observed anomaly persists across different nuclear targets and collision energies, eliminating trivial systematic explanations.

This suggests that the flavor content of the quark–gluon plasma or the intermediate hadronic states is influenced by deeper structural or dynamical factors not captured by the SM.

3.3 Emergence of Oscillatory Symmetry in NMSI

The **New Subquantum Informational Mechanics (NMSI)** provides a radically different explanation, grounded not in gauge symmetry but in **subquantum logical oscillations**.

In the NMSI framework, quark flavors (up, down, strange, etc.) are not fundamental constants of nature, but emergent **phase states** of underlying informational oscillators.

Each flavor represents a **stabilized resonance mode** within a multi-layered oscillatory network that interacts with the subquantum vacuum.

This interpretation allows for **dynamic switching** between flavor modes as a result of environmental parameters — such as energy density, local entropic flux, or topological constraints in the vacuum. In this sense, flavor symmetry breaking is not an anomaly, but a **natural consequence** of oscillatory phase transitions.

3.4 Logical Explanation of Flavor Asymmetry

Rather than treating the deviation as a statistical fluke, NMSI treats the **up/down imbalance** as a **phase shift** within the flavor oscillator system. In this logic-based view:

- Each quark flavor corresponds to a discrete logical phase within an entangled subquantum network.
- Transitions between flavors arise due to **entropic gradients**, not through weak interactions alone.
- The local environment in the collision zone (temperature, density, coherence) can induce **non-equilibrium resonance switching** that alters the apparent flavor yield.

This model predicts that in ultra-relativistic collisions, where subquantum coherence is perturbed, such asymmetries should systematically emerge and grow with energy.

3.5 Implications and Future Experiments

If the NMSI model is valid, then flavor ratios should vary in predictable ways with:

- Collision energy
- Nuclear species (target and projectile)
- Centrality and multiplicity of the event
- The degree of pre-hadronization entanglement

NA61/SHINE and future experiments such as **AFTER@LHC** and **CBM@FAIR** can test these predictions by analyzing flavor yields as functions of environmental parameters.

Furthermore, detecting **correlated phase asymmetries** in associated particle production (e.g., kaons, baryons) would support the idea that flavor is not intrinsic, but **contextual and emergent**.

3.6 Conclusion

The observed flavor symmetry violation in NA61/SHINE provides critical evidence for the limitations of the Standard Model and the need for a more fundamental theory. In the NMSI framework, such deviations are not irregularities but **signatures of deeper subquantum dynamics**, where oscillatory phase logic governs particle identity.

This reinterpretation opens the door to a **new understanding of flavor**, not as a quantum number but as a **transient resonance** in a vast oscillatory network — a stepping stone toward a unifying physics of information and matter.

Chapter 4 – CP Violation and FCNC in Charm Mesons and Top Quarks

4.1 Introduction: Fundamental Symmetries and Rare Decays

In the Standard Model (SM) of particle physics, CP symmetry (the combined symmetry of charge conjugation and parity) plays a central role in describing the behavior of matter and antimatter. A violation of this symmetry — known as CP violation — is a critical phenomenon, offering insight into why the observable universe is composed predominantly of matter.

Simultaneously, Flavor-Changing Neutral Currents (FCNC) are transitions between quark flavors without a change in electric charge, highly suppressed in the SM due to the Glashow–Iliopoulos–Maiani (GIM) mechanism. These processes are extremely rare and occur only via loop-level interactions.

Thus, any deviation from SM expectations in either CP-violating processes or FCNC transitions suggests potential new physics beyond the current theoretical framework, including the possibility of intermediate states or hidden dynamics not described by known particles.

4.2 Recent Experimental Data (LHCb and CMS)

Over the past decade, the LHCb and CMS collaborations at CERN have conducted highly sensitive measurements of charm meson decays and top quark transitions. Their findings include statistically significant anomalies in both CP violation and FCNC processes:

- Charm mesons (D^0): Direct CP asymmetries have been observed in decays such as $D^0 \rightarrow K^+K^-$ and $D^0 \rightarrow \pi^+\pi^-$, with combined deviations exceeding 5σ from SM predictions.
- Top quarks: CMS has reported excesses in rare decays such as $t \rightarrow Zc$ and $t \rightarrow \gamma u$, which are not accommodated by the SM's suppression of FCNC. Although no stable new particles have been observed in these channels, the frequency of such events significantly exceeds theoretical expectations.

These results point toward transient intermediate states or dynamics affecting the decay pathways, despite the lack of direct evidence for new massive particles.

4.3 Interpretation within the NMSI Framework

The New Subquantum Informational Mechanics (NMSI) model offers a novel interpretation of these anomalies. In NMSI, particles are not fixed point-like entities, but logical oscillatory systems embedded in a structured subquantum vacuum.

Key Concepts:
- CP symmetry is not merely a geometric inversion but a direction of phase alignment in a logical oscillatory network.
- CP violation corresponds to a logical phase jump — a transition between two coherent but differently oriented oscillatory states.
- FCNC events are interpreted as oscillatory reconfigurations of the internal logic network during interactions, generating temporary "phase-particle" intermediates that do not possess fixed mass or persistence, but still influence decay outcomes.

In this context, the observed excesses in rare decays are not the result of new physical particles, but of momentary topological configurations within the informational substrate of the vacuum.

4.4 Experimental and Theoretical Implications

If the NMSI interpretation holds, the anomalies observed at LHCb and CMS imply a paradigm shift in how we perceive fundamental interactions:

- Matter is not static: Its properties — mass, flavor, charge — are expressions of oscillatory phase logic, not immutable traits.
- Symmetries and conservation laws emerge from local equilibrium states in a multi-phase oscillatory system, and are subject to logical transitions.
- "Virtual particles" in quantum field theory may in fact be non-material phase nodes, which exist only as perturbations in the oscillatory structure, rather than as latent particles.

This perspective would unify disparate observations under a logical-oscillatory architecture that governs the behavior of all particles — particularly unstable ones like mesons and top quarks.

4.5 Conclusion

CP violation and FCNC events in charm mesons and top quarks provide fertile ground for testing emergent theories such as NMSI. The anomalies observed at CERN experiments are not necessarily signs of missing particles, but may reflect deeper informational phase transitions within the subquantum fabric.

By viewing these processes through the lens of NMSI, we reinterpret symmetry-breaking as a natural consequence of logical oscillatory shifts — transitions between coherent but non-equivalent phase states.

This insight deepens the connection between particle microphysics and the information-theoretic structure of the universe, suggesting that the true foundations of physics may lie not in fields and forces, but in logic, oscillation, and phase topology.

Chapter 5 – Anomalies in the Muon's Magnetic Moment (Muon g-2)

5.1 Introduction to the Anomalous Magnetic Moment

Within the framework of the Standard Model (SM) of particle physics, the magnetic moment of the muon is predicted with extraordinary precision using quantum electrodynamics (QED), complemented by hadronic and electroweak contributions. The magnetic moment of a charged particle with spin (such as the muon) is given by:

$\mu = g(e\hbar/2m)$

where g is the gyromagnetic factor. For a point-like particle, the theoretical value is $g = 2$, but quantum corrections lead to a notable deviation, known as the anomalous magnetic moment:

$a_\mu = (g - 2)/2$

5.2 The Muon g-2 Experiment (Fermilab)

The Muon g-2 experiment at Fermilab aims to measure this deviation with unprecedented accuracy, comparing it against Standard Model predictions. The data collected so far indicate a significant discrepancy:

Experimental result (2021):
$a_\mu^{(exp)} \approx 116{,}592{,}061 \times 10^{-11}$

Standard Model prediction:
$a_\mu^{(SM)} \approx 116{,}591{,}810 \times 10^{-11}$

This difference of approximately 4.2σ suggests a potential violation of the Standard Model and may point to the existence of new particles or subquantum interactions.

5.3 Interpretation within the NMSI Framework

In the New Subquantum Informational Mechanics (NMSI) model, the muon's anomalous magnetic moment is understood as a manifestation of an additional phased oscillation between the baryonic and subquantum components of the particle.

According to NMSI, the muon is not a point-like particle, but a logical oscillatory system that interacts with the informational vacuum via oscillatory entanglement.

In this framework, the g-2 discrepancy is viewed as a direct effect of a temporary imbalance between the muon's internal oscillation phases and the universal oscillatory field. The value of g becomes dependent on:
- The internal harmonic structure of the muon's oscillation
- The logical entropy accumulated through subquantum interactions

5.4 Implications for Validating NMSI

The persistence of this anomaly, despite increasingly precise experimental and theoretical corrections, reinforces the hypothesis that we are observing a deeper layer of physical reality than the one described by the Standard Model.

In the NMSI perspective, this anomaly is not a defect, but a logical signature of subquantum interaction. Key implications:
- The muon is a temporarily stabilized oscillator, with a lower frequency than the electron
- The shift in the g value is caused by antiphase oscillations generated by residual interactions with entangled subquantum infobits
- These interactions are logical in nature, and non-resonant with the Standard Model's gauge fields

5.5 Conclusion

The muon g-2 anomaly provides one of the strongest experimental bases for challenging the completeness of the Standard Model. Within the NMSI framework, this numerical deviation becomes a logical key to a new physics paradigm, where the subquantum vacuum actively shapes the quantum properties of matter.

The NMSI model offers a predictive alternative grounded in informational oscillation, phase entanglement, and logical interference. This approach redefines:
- Mass
- Magnetic moment
- Particle identity

…as emergent outcomes of stabilized oscillatory logic states.

Chapter 6 – CP Violation and FCNC in Charm Mesons and Top Quarks

6.1 Introduction: Fundamental Symmetries and Rare Decays

Within the Standard Model (SM) of particle physics, CP symmetry (Charge-Parity symmetry) plays a fundamental role in describing the behavior of matter and antimatter. Any violation of this symmetry—referred to as CP violation (CPV)—is considered a potential window into physics beyond the Standard Model (BSM), especially when seeking to explain the matter-antimatter asymmetry observed in the universe.

Simultaneously, Flavor-Changing Neutral Currents (FCNC) are predicted to be extremely rare processes in the SM, heavily suppressed due to the Glashow–Iliopoulos–Maiani (GIM) mechanism. Detecting deviations in the frequency or nature of these rare decays may indicate the presence of new intermediate states or interactions that fall outside the conventional SM particle chart.

6.2 Recent Experimental Data (LHCb, CMS)

In recent years, the LHCb and CMS collaborations at CERN have reported a series of observations consistent with anomalous behavior in rare decays of both charm mesons and top quarks. These anomalies are particularly evident in decay channels sensitive to direct CP violation and FCNC transitions.

Noteworthy examples include:

- In the case of D^0 mesons (containing charm–anticharm quark pairs), significant direct CP asymmetries have been detected in the decays
  $D^0 \rightarrow K^+K^-$ and $D^0 \rightarrow \pi^+\pi^-$,
  with cumulative deviations exceeding 5σ compared to SM predictions.

- CMS has reported an excess of events in rare top quark decays via FCNC channels, such as:
  $t \rightarrow Zc$ and $t \rightarrow \gamma u$,
  which are not compatible with SM expectations, although no direct signatures of new stable particles have been identified.

These observations suggest the possible transitory appearance of intermediate phase states, which may affect decay pathways without leaving direct traces in detectors in the form of conventional, massive particles.

6.3 Interpretation within the NMSI Framework

In the New Subquantum Informational Mechanics (NMSI) framework, CP symmetry is no longer viewed merely as a geometric or algebraic parity, but rather as a logical phase direction within the internal oscillatory network of particles.

- CP violation is not treated as an "error" or symmetry breaking in the classical sense but is instead interpreted as a logical phase jump between two stabilized oscillatory configurations.

- FCNC phenomena can be understood as the reorganization of internal logical oscillatory networks during particle interactions. This includes the temporary emergence of "phase particles"—entities that do not possess intrinsic mass or persist as detectable objects but nonetheless modulate the decay channel.

This interpretation removes the necessity to postulate new exotic particles to explain these deviations, replacing them with a subquantum dynamics of oscillatory phase transitions.

6.4 Theoretical and Experimental Implications

Should this interpretation be validated through further LHCb and CMS data, several important consequences follow:

- Matter is not static: it expresses its properties dynamically through oscillation and phase harmony.
- Opens the path to a logical physics of particles, where symmetries and conservation laws emerge from local oscillatory equilibria.
- Virtual particles are redefined: not as ephemeral quantum fluctuations but as transitory logical phase nodes—information structures rather than physical bodies.

This perspective fundamentally reorients our understanding of rare decay channels and symmetry violations, suggesting they are not exceptions but natural results of an oscillatory subquantum architecture.

6.5 Conclusion

The observed CP violations and FCNC decay anomalies in charm mesons and top quarks provide fertile ground for testing emerging theoretical models. The interpretation offered by NMSI not only explains these anomalies without invoking ad hoc exotic particles, but integrates them into a coherent framework of logical oscillations, where symmetry is emergent and deviation is a sign of evolutionary phase transitions.

This framework deepens the connection between particle microphysics and the informational architecture of the universe, introducing a new paradigm wherein physical properties emerge from stabilized subquantum logic.

Chapter 7 – The Chiral Anomaly: Not an Anomaly, but a Signature of Oscillatory Asymmetry

7.1 Introduction: Revisiting the Chiral Current and Its Non-Conservation

In the Standard Model, the conservation of the axial (chiral) current is expected in massless fermion systems. However, quantum effects such as triangle diagrams with fermion loops lead to an anomaly – a violation of this conservation. This so-called chiral anomaly appears as a contradiction between classical symmetry and quantum behavior, particularly in the presence of external fields like electromagnetism.

Traditionally, this anomaly is treated as a minor quantum correction. Yet, its persistence and topological nature suggest a much deeper origin.

7.2 The NMSI Perspective: Chiral Asymmetry as a Logical Phase Shift

In the framework of the New SubQuantum Informational Mechanics (NMSI), the chiral anomaly is not a flaw, nor an exception, but a fundamental signature of a deeper subquantum oscillatory structure. Within this theory:

- The axial current is not fundamental, but rather an emergent expression of an internal oscillatory configuration in the informational vacuum.

- The non-conservation of this current is due to the interference between logically stabilized oscillatory states existing in distinct phase regimes.

- The appearance of the E·B term in the continuity equation (involving electric and magnetic fields) is interpreted in NMSI as a transition term that reflects information exchange between distinct oscillatory realities (e.g., baryonic vs. non-baryonic).

7.3 Topological Asymmetry and Logical Vector Rotation

The chiral asymmetry, in NMSI, stems from the unidirectional rotation of the phase vector in a structured, subquantum vacuum. Unlike classical models, where symmetry breaking is external or stochastic, NMSI posits:

- A structured logic of oscillation, where left- and right-handedness represent stable phase configurations in different logical sectors.

- The anomaly is not an exception but the natural result of encountering a phase boundary or informational phase transition, analogous to domain walls in condensed matter physics.

This model is topologically coherent with the behavior of solitons or edge states in systems with topological order, but extended into the realm of particle physics.

7.4 Implications for High-Energy Experiments

Reanalysis of high-precision data, particularly from:

- Electron–positron collision experiments, where anomalies in helicity transitions are observed,

- And studies in axial vector mesons,

confirms subtle but systematic deviations from the conservation laws expected by the Standard Model.

These deviations:

- Align with the predictions of NMSI when modeled as logical phase jumps in an oscillatory network,

- Suggest that chirality is not a fixed symmetry but a transitory state in a dynamic oscillatory system.

7.5 Reference Study: GSJournal Article, 2025

The article authored and published in GSJournal by Prof. Dr. Sergiu Vasili Lazarev in 2025, titled “The Chiral Anomaly Is Not an Anomaly: Reinterpreting Quantum Symmetries through Subquantum Oscillatory Physics (NMSI)”, elaborates the mathematical foundation of this reinterpretation. The study provides:

- A topological-logical mapping of the axial current,

- Derivation of the anomaly equation from oscillatory logic,

- Justification of anomaly persistence as a signature of vacuum structure.

7.6 Conclusion

In the NMSI framework, the chiral anomaly transforms from an exception into a predictive, structured phenomenon. It is not a breakdown, but a manifestation of deeper logic embedded in the vacuum oscillatory architecture. This perspective opens a pathway toward:

- A redefinition of fundamental quantum symmetries,

- Integration of quantum field theory with topological quantum computation concepts,

- And exploration of new degrees of freedom in matter structure, stemming from subquantum informational logic.

Chapter 8 – Four Top Quark Events, Diphotons, and Heavy Higgs Bosons

8.1 Observations in Run-2 and Run-3 (2023–2025)

During the most recent data-taking periods at the LHC (Run-2 and Run-3), the ATLAS and CMS collaborations have reported a growing number of anomalous events that challenge the predictions of the Standard Model (SM). Among these, the most notable include:
- A statistically significant excess in events involving four top quarks ($t\bar{t}t\bar{t}$), with cross sections well above SM expectations.
- The observation of diphoton resonances that do not match the profile of known particles, suggesting the presence of new intermediate states.
- Emerging signs of heavy Higgs-like resonances with masses exceeding 700 GeV, often associated with boosted topologies or enhanced diphoton yields.

These results cannot be explained within the standard two-doublet Higgs model or through loop-level corrections alone. As such, they suggest the existence of new physical structures or reconfigurations of the vacuum state.

8.2 Beyond the Standard Higgs Mechanism

The SM describes the Higgs boson as a fundamental scalar field responsible for electroweak symmetry breaking and mass generation. However, the emergence of heavier resonances and four-top anomalies point toward the existence of a more composite or oscillatory structure of the Higgs sector:

- Several extensions to the SM propose composite Higgs bosons, built from new fermionic constituents or bound states of exotic particles.
- Other hypotheses introduce bosons of transition, which act as mediators between different vacuum phases or topological states of the field.

Yet, even these models face difficulty explaining the high coherence and sudden appearance of multiple heavy objects in strongly correlated configurations.

8.3 Interpretation in the NMSI Framework

In the NMSI (New Subquantum Informational Mechanics) paradigm, the so-called Higgs bosons are not fundamental entities, but logical rearrangements of oscillatory structures within the subquantum vacuum. According to this view:

- The Standard Model Higgs is a localized stabilization effect of oscillatory phase coherence at a specific energy threshold.
- Heavy Higgs-like bosons are not new particles per se, but manifestations of phase transitions between deeper topological layers of the vacuum. These transitions involve reconfigurations of subquantum logical networks.

The NMSI model predicts that such configurations may occur spontaneously when specific coherence conditions between oscillators are met, especially in the presence of strongly interacting systems like top quark quartets.

8.4 Four-Top Events as Oscillatory Resonances

The four-top anomaly is interpreted in NMSI not as the production of four independent top quarks, but as the formation of a meta-resonance, a topological oscillatory node composed of phase-entangled heavy quarks. The key characteristics are:

- High internal phase symmetry due to identical quark types;
- Logical coherence with the surrounding field, acting as a transient calculation center of vacuum oscillations;
- Possible transformation into Higgs-like energy bursts (e.g., diphotons) upon phase decoherence.

Such meta-nodes behave as temporary logic structures, not stable particles, and their 'decay products' represent the dissociation of a topologically stabilized configuration.

8.5 Implications and Experimental Probes

If confirmed, this interpretation would radically shift our understanding of the Higgs sector and mass generation. Rather than being a single scalar particle, the Higgs field becomes:
- A manifestation of coherent subquantum logic, dynamically reconstructed during high-energy events;
- Capable of generating multiple resonance signatures depending on the local oscillatory configuration;
- Interacting with the visible field only through phase shifts, diphotonic bursts, or flavor oscillations.

Experiments could test these predictions by:
- Analyzing angular correlations and spin alignment in four-top events;
- Searching for phase-related patterns in heavy diphoton events;
- Investigating resonance drift and shape variability across luminosity bins.

8.6 Conclusion

The recent excesses involving four top quarks, heavy diphotons, and novel Higgs-like states do not demand the invention of exotic new particles, but rather invite a deeper reinterpretation of the vacuum structure itself. In the NMSI view, these phenomena are emergent results of oscillatory logic, where matter is not built from static building blocks, but from entangled fluctuations of phase across subquantum domains.

This model not only unifies anomalies previously considered isolated, but also paves the way for a new informational understanding of fundamental interactions.

Chapter 9 – Integrative Interpretation within the NMSI Framework Conclusions and Perspectives

Experimental Reinterpretation through Phase Logic

The New Subquantum Informational Mechanics (NMSI) offers a fundamentally different lens through which to interpret anomalies in high-energy physics. Unlike the Standard Model, which treats particles as point-like entities with static intrinsic properties, NMSI describes all particles and interactions as emergent phenomena of logical oscillatory networks embedded in a structured subquantum vacuum.

From this viewpoint, each experimental anomaly described in the preceding chapters is not an isolated deviation but a phase signature—an imprint of deeper oscillatory configurations modulated by logical phase dynamics. Rather than postulating new massive particles, NMSI decodes these anomalies as transitions between coherent oscillatory states within a dynamic information field.

Oscillatory Nodes and Topological Entanglement

In the NMSI model, elementary particles are interpreted as oscillatory nodes—temporary stabilization points of phase-coherent interactions in the subquantum vacuum. These nodes are characterized by:

- Harmonic identity, defined by intrinsic frequency and logical spin;
- Entanglement topology, reflecting the network of informational resonance with other oscillators;
- Emergent physical properties (mass, charge, magnetic moment) as dynamic projections of this logic-phase configuration.

Topological entanglement within these networks mirrors phenomena already observed in quantum computing and condensed matter physics, such as non-Abelian anyons or quantum Hall effects. In NMSI, such entanglement is not an exotic exception but a fundamental feature of particle identity.

Logical Computing and the TQC Analogy

The architecture of these subquantum oscillatory systems can be formally compared with Ternary Quantum Computing (TQC) networks. Each oscillatory node acts as a logical gate, operating not on bits or qubits, but on infobits—subquantum packets of phase-configured information. The collective behavior of such nodes gives rise to emergent, observable particles and interactions.

This analogy allows the application of mathematical tools from topological quantum computation and phase logic circuits to:

- Model the behavior of complex interactions;
- Explain transient anomalies as logical oscillation shifts;
- Predict new oscillatory configurations beyond current experimental reach.

Conclusions and Perspectives

A Coherent Framework for Anomaly Unification

Through its informational and oscillatory reinterpretation of quantum anomalies, NMSI provides a cohesive and predictive framework. It explains a wide range of experimental results—including CP violation, chiral asymmetry, g–2 anomalies, and unexpected resonance formations—without invoking ad hoc particles or symmetry breaking.

By grounding the behavior of matter in phase-stabilized logical oscillations, NMSI resolves contradictions within the Standard Model and opens the door to a deeper understanding of quantum phenomena.

Future Experimental Directions

To validate and further develop this paradigm, the following lines of experimental research are essential:

1. Direct measurement of phase shifts and oscillatory coherence in high-energy scattering;
2. Correlation studies between entanglement patterns and decay asymmetries;
3. Subquantum field mapping, potentially using interferometric methods or modified detectors sensitive to phase patterns;
4. Simulation of NMSI dynamics using ternary logic architectures or neural quantum systems.

Redefining the Concept of Particles

Within NMSI, the term "particle" is no longer synonymous with a stable object in space-time. Instead, it denotes a temporarily stable logical configuration—a point of resonance within a dynamic network of phase-entangled oscillators. As such:

- Mass is a function of phase stability and oscillation amplitude;
- Charge and spin arise from internal phase asymmetries;
- Identity is maintained by persistent entanglement patterns.

This redefinition aligns not only with the latest experimental data but also with philosophical expectations of a unified theory—one where matter, energy, and information are fundamentally inseparable.

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