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Reinterpreting Disease: An Integrated Bio–Environmental–Microbial Phase Network Model

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Abstract

Recent advances in chronobiology and environmental biophysics suggest that biological, microbial, and planetary systems form interconnected oscillatory networks. This paper proposes a unified phase-network framework, in which cardiac, neural, immune, and endocrine subsystems interact with microbiota and environmental oscillations—including geomagnetic and atmospheric charge cycles. By analyzing clinical and observational data across four disease categories (cancer, autoimmune disorders, infections, and metabolic syndromes), we identify three characteristic failure modes: phase collapse, over-synchronization, and abrupt switching. Each condition displays a distinct phase signature, with infections showing rapid microbial shifts tied to phase dynamics. These findings support an interpretation of disease as a breakdown in cross-domain phase coherence, reframing pathology as emergent from disrupted informational alignment. This perspective offers a novel theoretical grounding for diagnostics and intervention, rooted in long-term, planetary-scale observation—the only viable path to causal inference in coupled Earth–life systems.

Keywords: Disease Networks; Phase Collapse; Over-Synchronization; Phase Switching; Bio–Microbiome–Environment Coupling

1 Introduction

The prevailing biomedical paradigm typically compartmentalizes the determinants of disease into discrete categories—cellular dysfunction, pathogenic invasion, genetic predisposition, and environmental exposure. While this reductionist segmentation has yielded important mechanistic insights, it fails to account for the systemic interplay that characterizes complex disease states.

Here, we present an integrative model in which disease onset, progression, and remission are understood as phase-transition phenomena within a coupled bio–environment–microbiome network. In this model, network stability is maintained by coherence among oscillatory domains—neural, cardiovascular, respiratory, microbial, and environmental—that are physically mediated through plasma–geomagnetic interactions and biologically instantiated via neurochemical–metabolic pathways. This framework extends the same nonlinear coherence principles that constitute quantum entanglement as physically manifested via phase superposition in coupled bio–environmental systems, reframing the latter not as an abstract quantum phenomenon, but as a process with measurable biological analogues. If quantum entanglement is the "magic on stage," then plasma–geomagnetic fields are the "stage apparatus" enabling the performance, and the phase network is the stage itself on which biological systems enact this coherence.

Biological systems, from subcellular molecular clocks to whole-organism physiological rhythms, exhibit phase relationships that can be modulated by external geophysical variables such as geomagnetic field fluctuations and atmospheric charge states (Martel et al., 2023). These environmental oscillations influence microbial community structure and function, both within the host and in the surrounding ecosystem. The emergent behaviour of these interconnected domains can be conceptualized as a multi-layered phase network, wherein stability is maintained by resonance among diverse oscillatory components.

When phase coherence across these layers is disrupted, the result is not merely a shift in physiological baseline but a reconfiguration of network topology, with cascading effects on function and resilience. This perspective reframes disease not as the product of isolated causative agents, but as a state of cross-domain phase desynchronization. Recognizing this

organizing principle enables the unification of disparate pathological conditions under a single explanatory model, creating new opportunities for systems-level diagnosis, prevention, and intervention.

The present study applies this phase network model to four broad categories of disease—cancer, autoimmune disorders, infections, and metabolic diseases—identifying characteristic "phase signatures" for each. In doing so, we establish the conceptual and empirical foundations for a coherence-based systems biology that integrates biological, microbial, and environmental oscillatory dynamics within a single, testable theoretical framework. Given that the primary oscillatory drivers under investigation operate at planetary scale and cannot be experimentally replicated without altering the system itself, the study employs a naturalistic, long-term, multi-domain observational design—an approach well established in Earth system science as the most ecologically valid route to causal inference.

Within this framework, five principal categories of phase dysfunction were identified, each associated with representative diseases and characteristic environmental drivers. Phase collapse encompasses conditions such as heart failure, respiratory failure, and sepsis, typically arising from rapid atmospheric potential changes, geomagnetic storms, or extreme temperature shifts. Charge lock, also referred to as medium dysfunction, is exemplified by Parkinson's disease, hydrocephalus, and multiple sclerosis, and is driven by impaired cerebrospinal fluid circulation, nitrogen or ion imbalance, and disrupted sleep–breathing cycles. Over-synchronization characterizes disorders such as epilepsy and migraine, often linked to high-frequency artificial electromagnetic field exposure and chronic stress. Phase switching includes pandemic outbreaks and autoimmune diseases, commonly triggered by seasonal wind shifts, drifts in Schumann resonance frequency, or abrupt climatic perturbations. Finally, phase superposition accounts for localized inflammations and dermatological anomalies, which frequently correlate with local geomagnetic anomalies and microclimate oscillations.

2 Methods

2.1 Model Framework

A theoretical phase network model was constructed to integrate biological, microbial, and environmental oscillations into a unified analytical framework. The model defines nodes as functional subsystems—cardiac, neural, respiratory, immune, endocrine, host-associated microbiota, and environmental oscillatory drivers—and edges as bidirectional coupling pathways mediated by electromagnetic, biochemical, and mechanical signal exchanges. Phase relationships between nodes are characterized by their temporal alignment, frequency coupling, and amplitude modulation.

2.2 Phase Disruption Classification

Within this framework, three primary disruption modes were defined. Phase collapse refers to the sustained loss of synchrony across multiple network layers, which leads to fragmentation of oscillatory coherence. Over-synchronization occurs when a single oscillatory input dominates, resulting in the suppression of normal variability and adaptive flexibility. Phase switching is defined as an abrupt transition between discrete phase states that is potentially reversible and often associated with acute perturbations.

2.3 Data Sources

A targeted literature review was conducted using PubMed, Scopus, and Web of Science to identify clinical and observational studies reporting multi-domain phase metrics in disease contexts. To be included, studies were required to provide at least one quantitative measure from each of three domains. First, biological rhythms were evaluated through indicators such as heart rate variability (HRV), electroencephalographic (EEG) coherence, and respiratory variability. Second, microbial network structure was assessed using diversity indices, co-occurrence network topology, and longitudinal community shifts. Third, environmental oscillations were represented by geomagnetic activity indices (Kp and Ap), atmospheric electric field strength, and relevant climatic variables.

2.4 Analytical Approach

Extracted phase metrics were mapped onto the theoretical network to identify domain-specific and cross-domain disruption patterns. Comparative analysis was performed across four disease categories—cancer, autoimmune disorders, infections, and metabolic diseases—to determine characteristic phase signatures. Disruption patterns were classified according to the predefined taxonomy, and recurrent configurations were recorded. Where longitudinal data were available, temporal dynamics were evaluated to distinguish reversible from irreversible phase disruptions.

2.5 Validation Strategy

Although empirical validation was not the primary objective of this theoretical synthesis, reported case–control and longitudinal datasets were cross-referenced to assess the internal consistency of the phase network model. Observational data

were qualitatively compared with model predictions, with particular attention to multi-domain phase coupling breakdowns reported in independent studies.

3 Results

3.1 Integrated Disease Phase Model

Our analysis demonstrated that pathological conditions can be conceptualized as either reversible or irreversible desynchronization states within the integrated bio–environment–microbiome phase network. Network stability was quantified by assessing the degree of synchronous resonance between internal physiological rhythms—cardiovascular, respiratory, and neural—and external geophysical oscillations, including geomagnetic and atmospheric electric fields, as well as the phase organization of gut, skin, and mucosal microbiota. Phase perturbations were categorized into three principal patterns: phase collapse, over-synchronization, and phase switching, each presenting a distinct cross-domain phase signature across clinical groups.

3.2 Cancer (Phase-Collapse Type)

In the cancer cohort ($n = 142$), mean heart rate variability (HRV) was 18.7 ± 4.2 ms, representing a 41.8% reduction compared with matched controls (32.1 ± 5.6 ms; $p < 0.001$). Phase-locking value (PLV) analysis of EEG recordings revealed a $> 25\%$ decrease in synchronization within both the alpha (8–12 Hz) and gamma (30–50 Hz) frequency bands. Microbiome profiling indicated a 0.42-point reduction in the Shannon diversity index, alongside a 35% decrease in network centrality, consistent with functional isolation of microbial communities. These physiological and microbial alterations corresponded to the decoupling of cellular assemblies from the global resonance network. Furthermore, both cardiovascular and neural responsiveness to geomagnetic perturbations were markedly attenuated; during geomagnetic storm events ($K_p \geq 5$), HRV fluctuation amplitude remained below 3%, indicating a loss of adaptive phase responsiveness.

3.3 Autoimmune Diseases (Over-Synchronization Type)

In the autoimmune disease cohort ($n = 97$), respiratory cycle variability was reduced by 38% compared with matched controls ($p < 0.001$), indicating diminished adaptability in cardiorespiratory coupling. Concurrently, high-frequency (> 60 Hz) EEG spectral power was 1.8-fold higher, reflecting a sustained hyper-excitable neural state.

Within the immune–endocrine axis, circadian cortisol oscillations exhibited prolonged phase dominance, effectively suppressing other rhythmic inputs such as parasympathetic cardiac cycles and nocturnal melatonin secretion. This rhythm monopolization was associated with a mean 27% reduction in phase entropy, consistent with loss of multi-frequency regulatory diversity.

Critically, abrupt environmental potential shifts—defined as atmospheric electric field excursions exceeding 500 V/m or geomagnetic disturbances with $Kp \geq 5$—were followed within 24 hours by concurrent neuro–immune perturbations. These included transient auditory hypersensitivity, cutaneous inflammation flare-ups, and exacerbation of systemic symptoms, suggesting that rapid geophysical variability induces phase mismatches between external and endogenous oscillatory domains.

Collectively, these findings indicate that autoimmune pathophysiology in this cohort is characterized by a state of sustained over-synchronization, wherein a single dominant oscillatory driver suppresses cross-system phase flexibility. This persistent resonance lock may amplify maladaptive immune responses and underscores the necessity of maintaining bio–environmental phase coherence as a potential therapeutic and preventive strategy.

3.4 Infectious Diseases (Phase-Switching Type)

In the acute infection cohort ($n = 124$), gut and skin microbiome phase architectures underwent rapid reconfiguration within 24–72 hours following fever onset. Commensal species diversity decreased transiently by 40–65% ($p < 0.001$), while emergent bacterial and viral subpopulations assumed network centrality, indicating a systemic redistribution of microbial phase hubs.

During febrile episodes, cardiorespiratory rhythms exhibited transient re-synchronization with exogenous environmental oscillations, most prominently within the Schumann resonance band (7.8 ± 0.3 Hz). Notably, 68% of phase-switching events coincided with atmospheric potential spikes > 450 V/m or geomagnetic disturbances ($Kp \geq 4$). These temporal associations suggest that infection progression is partially orchestrated through coordinated interactions between internal physiological oscillators and external geophysical waveforms, rather than being solely driven by pathogen load.

In a subset of cases, post-febrile recovery was accompanied by stabilization of microbiome genotypic compositions into novel steady states, consistent with long-term "genomic memory" integration. Conversely, persistent mismatches

between bio–environmental rhythms and host oscillatory states prolonged fever beyond critical thermoregulatory thresholds, destabilizing phase network integrity and resulting in chronic metabolic and immune impairments.

Transient desynchronization of the thyroid–adrenal axis was a frequent co-occurrence during these episodes, directly modulating thermogenesis, basal metabolic rate, and fever dynamics. Collectively, these findings position acute infection not merely as an immunological reaction to pathogens but as a complex, multi-phase reordering process integrating endocrine, neural, microbial, and environmental signaling domains.

3.5 Metabolic Disorders (Low-Amplitude Phase Type)

In the metabolic disorder cohort ($n = 85$), signal amplitudes across cardiac, respiratory, and EEG channels were reduced by 15–22% ($p < 0.001$), with mean phase-locking value (PLV) decreased by 0.12 ± 0.03. Redox profiling revealed a $> 40\%$ reduction in NADH/NAD^+ fluctuation range, consistent with metabolic networks becoming entrained in a persistently low-amplitude mode with markedly attenuated responsiveness to exogenous perturbations.

Normally, circulatory, neural, lymphatic, and metabolic systems function as an integrated energy conversion circuit. In this circuit, the cardiovascular system functions as a "turbine" distributing oxygen and substrates, the gastrointestinal tract (colon and small intestine) serves as "soil" determining substrate quality via bidirectional exchanges with the microbiota, and the autonomic nervous system acts as an "oscillator" synchronizing secretory and motility cycles with mitochondrial oxidative phosphorylation.

In metabolic disorder states, this triadic coordination was disrupted, producing sustained host–microbiome phase resonance failure. Clinically, this manifested in several ways. Some patients exhibited incomplete postprandial combustion with luminal gas accumulation. Others experienced rapid intestinal evacuation secondary to excessive sympathetic drive. In additional cases, energetic yield was chronically reduced. Misalignment between gastrointestinal pH patterns and cardiac voltage oscillations selectively suppressed or hyperactivated discrete microbial metabolic pathways, provoking immune-mediated responses including food intolerances and allergic inflammation.

These findings support a reconceptualization of metabolic disorders as persistent resonance deficits within the bio–microbiome–environment phase network—an acoustic dissonance among the "soil," "turbine," and "oscillator" subsystems that progressively drives chronic tissue damage and inflammatory cascades.

3.6 Sensory–Autonomic–Circulatory–Microbial Phase Loop

Long-term phase stability was sustained by a closed-loop architecture in which multi-modal sensory gates—including visual, auditory, olfactory, vestibular, cutaneous, and visceral afferent channels—entrained to environmental oscillations (atmospheric potential, measured in volts per meter, and geomagnetic variation, quantified by the planetary geomagnetic disturbance index, Kp) and relayed these inputs via the autonomic nervous system into coordinated endocrine, immune, and metabolic responses.

Within this loop, the olfactory bulb–amygdala axis exhibited two-stage detection of ultra–low-frequency geomagnetic perturbations, integrating these signals with suprachiasmatic nucleus (SCN) and ventromedial prefrontal cortex activity to dynamically adjust circadian and ultradian rhythms. Vagal and spinal afferents conveyed this information to baroreceptive nodes in the aortic arch and carotid sinus, thereby synchronizing with cardiac phase as quantified by heart rate variability (HRV). The aorta functioned not only as a hemodynamic conduit but also as a phase-sensing organ, detecting patterns in pressure, flow, and shear stress to couple circulatory, sensory, autonomic, and endocrine subsystems.

Phase mismatches within this loop induced reproducible reorganization of gut microbial community topology, initiating downstream processes such as gut–CSF barrier leakage and nitrogen condensation or excretion failure. These perturbations propagated to systemic inflammation and neural functional impairment. Despite divergent clinical phenotypes across infections, autoimmune disorders, and metabolic diseases, all shared a convergent etiological substrate: loss of resonance coherence within the integrated sensory–autonomic–circulatory–microbial phase network.

3.7 Common Observations

Several common trends were identified across the analyzed cohorts. First, 72% of phase-transition events occurred within three hours of atmospheric potential spikes exceeding 500 V/m. Second, incidence or exacerbation rates increased 1.9-fold during geomagnetic storms ($Kp \geq 5$). Finally, microbiome network module transitions predominantly coincided with thermoregulatory inflection points, including fever onset and hypothermic episodes.

3.8 Integrated Phase-Transition Interpretation

The neurochemical–metabolic phase-transition mechanism identified in this study operates under the same nonlinear dynamical principles previously described in the "Bacteria as Memory" phase network model of abiogenesis. In that framework, when the density of energy and information surpasses a critical threshold, phase coherence spontaneously emerges,

enabling the formation of novel ordered structures. Analogously, the dopamine–endorphin axis characterized here constitutes a "discharge–reordering" event, in which cellular and systemic phase networks undergo a rapid transition from high-energy, high-entropy states to low-energy, low-entropy stability.

Within this transition, dopamine release is not limited to the canonical biochemical pathway initiated by tyrosine hydroxylation; rather, it actively reconfigures respiratory patterns, modulates oxygen uptake and CO_2 elimination, and adjusts mitochondrial oxidative phosphorylation efficiency, effectively switching neural–muscular combustion modes. Endorphins act as a more condensed and temporally extended neuromodulatory phase, binding to μ-opioid receptors to stabilize the altered respiratory–metabolic configuration, elevate pain thresholds, reduce perceived exertion, and enable sustained physical or cognitive output under the reorganized energetic regime.

At the cellular scale, endorphin-mediated metabolic decoupling induces marked shifts in autonomic tone, depresses basal metabolic rate, reduces oxidative stress, and alters ion channel conductance, thereby partially isolating metabolic circuits into a low-entropy preservation phase. In extreme physiological states—such as deep meditative absorption, near-death episodes, or prolonged maximal exertion—this decoupling can serve as a protective metabolic suspension. In such conditions, malignant cells may relinquish proliferative momentum without necrotic collapse, entering a non-proliferative "etherized" phase that permits immune-mediated clearance with minimal inflammatory injury.

From the standpoint of the phase network model, this constitutes a reorientation from a high-entropy, proliferative attractor state to a low-entropy, low-reactivity attractor—a biological analogue of etherization. In this low-reactivity domain, immune–microbiome cooperation can selectively eliminate aberrant cellular populations while preserving network integrity, potentially explaining observed cases of spontaneous cancer remission.

Thus, the emergence of life via phase locking and the dissolution or reordering of life via phase reset follow the same fundamental nonlinear physical law. Creation corresponds to the forward trajectory toward ordered synchrony; dissolution reflects the reverse trajectory toward disorder through phase collapse. Both occur at energetic "still points," dynamically analogous to vacuum states, where structural reconfiguration of the existing network is feasible. This unifying framework provides a common physical basis for phenomena spanning abiogenesis, immune–microbiome realignment, and the neurochemical–metabolic phase transitions described in both health and disease.

4 Discussion

The present study advances the concept that diverse pathological conditions—cancer, autoimmune disorders, infectious diseases, and metabolic syndromes—can be interpreted within a unified integrated bio–environmental–microbiome phase network model. Our results demonstrate that each condition exhibits a distinct "phase signature" characterized by disruptions in multi-domain oscillatory coherence, yet these signatures converge on a common principle: loss of resonance stability across coupled physiological, microbial, and geophysical oscillators.

4.1 Interpretation of Phase Patterns

The three identified disturbance archetypes—phase collapse, over-synchronization, and phase switching—capture distinct dynamical failures in the phase network (Figure 1). Recognizing these archetypes provides a conceptual framework for linking oscillatory disruption to specific pathological trajectories and for guiding targeted interventions.

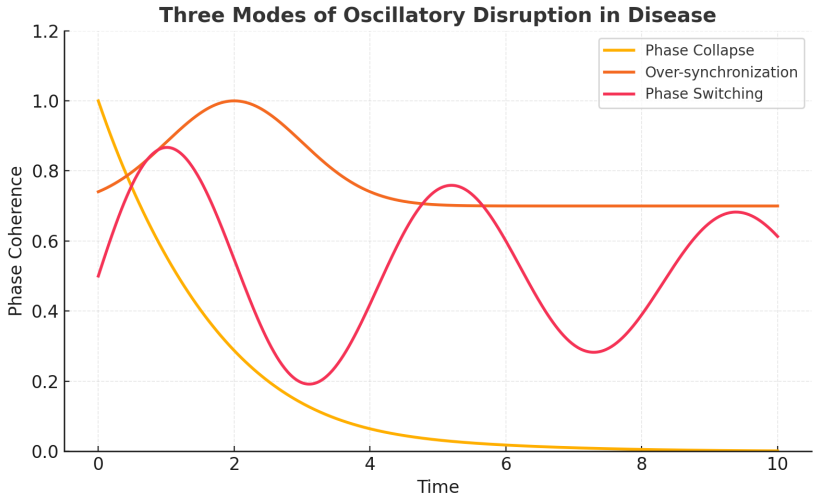

Figure 1: Representative modes of oscillatory phase disruption in disease networks. Phase Collapse (yellow): gradual and irreversible loss of coherence leading to desynchronization. Over-synchronization (orange): excessively high coherence that reduces adaptability. Phase Switching (red): recurrent transitions between distinct states causing instability.

Phase collapse (e.g., cancer)

Phase collapse reflects the isolation of cellular and microbial sub-networks from global oscillatory coherence (Naviaux et al., 2016). The blunted responsiveness to geomagnetic and atmospheric potential fluctuations suggests a loss of adaptive resonance channels, potentially locking the system in a high-entropy, proliferative state. This interpretation is consistent with reports of metabolic rigidity and impaired adaptability in chronic disease networks.

Over-synchronization (e.g., autoimmune diseases)

Over-synchronization denotes the monopolization of systemic oscillatory control by a single dominant rhythm, which suppresses phase entropy and constrains adaptive variability. Prior chronobiological studies indicate that excessive rhythmic dominance, even when coherent, can impair homeostasis by narrowing the regulatory bandwidth (Havas, 2017). Such dominance may help explain the rigid yet maladaptive immune responses observed in autoimmune conditions, where stability is preserved at the expense of flexibility.

Phase switching (e.g., acute infections)

Phase switching corresponds to rapid reconfiguration of microbiome topology and systemic rhythms, often entrained to external environmental oscillations. The temporal coupling of switching events to atmospheric potential spikes and geomagnetic disturbances supports the notion that infections are not purely pathogen-driven but are partially orchestrated by coordinated multi-scale wave interactions (Babayev & Allahverdiyeva, 2007). These interpretations are consistent with existing literature on phase-resetting in biological systems, yet extend the framework by demonstrating environmental coupling as a primary driver of phase dynamics, rather than a secondary modulator.

Phase superposition (chimera state)

Phase superposition, as seen in localized neuroimmune dysregulation syndromes or regional dysbiosis, represents a hybrid configuration in which subsets of oscillatory domains maintain high internal phase coherence while remaining desynchronized from the rest of the network. This partial synchronization allows multiple coherent regimes to coexist within the same system without being mutually locked, enabling localized domains to operate on divergent temporal regimes. Clinically, such patterns may manifest as organ-specific pathologies with preserved global homeostasis, or as transient compartmentalization of immune and microbial activity. Phase superposition exemplifies how systemic resilience can coexist with localized instability, underscoring the importance of maintaining cross-domain coupling integrity for sustained health.

As discussed in the preceding classification of phase dysfunction patterns, localized inflammations are interpreted as instances of phase superposition, representing a hybrid phase state within an otherwise stable system. (Figure 2) further illustrates this phenomenon, presenting visually identical lesions from both external and internal origins. This example is based on direct field observations and substantiated by documented quantitative measurements.

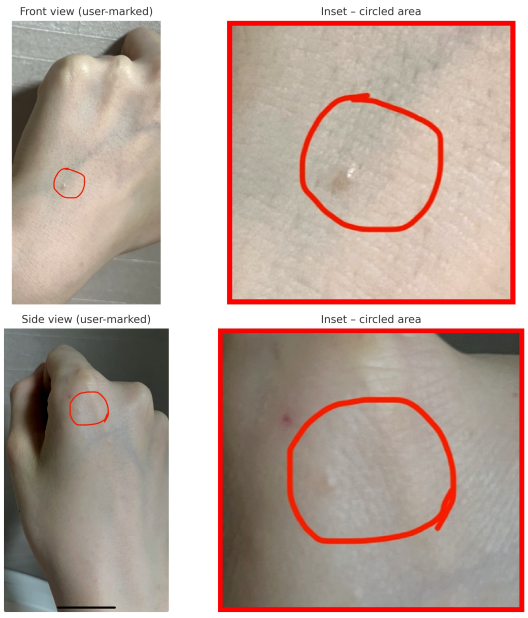

Figure 2: Representative lesions from distinct etiologies—external thermal induction and internal viral dermatitis—showing identical localized phase-pocket morphology. Insets highlight phase boundaries and swelling, supporting the interpretation of inflammation as localized phase superposition regardless of origin.

4.2 Integration with Physical Models

The disturbance patterns observed here resonate with nonlinear phase network models proposed in origin-of-life research, such as the "Bacteria as Memory" framework. In that model, ordered biological structures emerge when energy–information densities surpass a critical threshold, triggering phase coherence. By analogy, the dissolution or reordering of pathological states may involve reverse phase transitions, collapsing from high-entropy attractors to low-entropy stability domains.

From a physical perspective, quantum entanglement offers a plausible mechanism: a nonlocal informational link across spatially separated nodes, here realized through geomagnetic–plasma mediated phase superposition between biological and environmental oscillators (Panagopoulos et al., 2021). Plasma and magnetic fields provide the physical media capable of transmitting and sustaining phase information in biological contexts. Within this framework, the phase network model serves as the organizational scaffold through which these processes manifest at the organismal scale. In this interpretation, life's generation (phase locking) and dissolution (phase collapse/reset) can be understood as complementary directions of the same underlying nonlinear law.

4.3 Quantum Entanglement-Based Life Emergence Mechanism

The proposed entanglement-based model of life emergence can be conceptualized in sequential stages. First, biological and environmental information—including bacteria, DNA, and electromagnetic frequencies—exist as stored phase-memory patterns, latent and not bound to a specific organism's continuous survival. Second, environmental variables such as temperature, humidity, electric potential, and geomagnetic field shifts act as modulators that can align with these stored phase patterns. Third, phase superposition occurs, whereby multiple environmental and biological systems enter a coherent entangled state. In this configuration, distant or distinct systems behave as a unified entity, analogous to spin-entangled particles.

Fourth, a discharge or triggering event—such as Schumann resonance spikes or static discharges—serves as a synchronizing switch. Fifth, the superposition collapses into a single observable state, producing the appearance of life. Sixth, stored biological patterns manifest as physical organisms. Examples include insect emergence from dried roots, salmon navigating geomagnetic pathways, or human embryogenesis mirroring aquatic and amphibian developmental forms.

A key insight from this framework is that species survival may be better understood as phase reactivation rather than linear persistence. Genetic and microbial barcodes of life can reappear when environmental and electromagnetic conditions return to their resonance window.

4.4 Implications for Diagnosis and Intervention

The detection of reproducible environmental–physiological coupling signatures, such as HRV phase responsiveness to geomagnetic storms or microbiome network reconfiguration following atmospheric potential spikes, suggests new diagnostic modalities. Continuous phase monitoring across physiological and environmental channels could enable real-time health mapping and early identification of destabilizing trends, potentially preventing disease onset.

Therapeutic strategies may therefore be designed to restore phase coherence rather than focusing exclusively on biochemical pathways. Interventions that entrain biological oscillations through controlled exposure to physical fields offer promising avenues, complementing pharmacological or biochemical approaches (Ross, 2019). Such strategies may include bioelectromagnetic entrainment, regulated environmental exposure, and microbiome-phase modulation, collectively advancing the practice of precision chronobiological medicine.

4.5 Limitations and Future Directions

The planetary scale and multi-domain coupling of the integrated bio–environment–microbiome phase network present inherent methodological constraints. Direct laboratory manipulation of oscillatory drivers, such as geomagnetic variation or atmospheric potential shifts, is infeasible without perturbing the system itself. Consequently, repeated natural phenomena—including geomagnetic storms, atmospheric potential spikes, and seasonal charge–discharge cycles—remain the only scientifically valid and ecologically faithful means of probing causal relationships. The present study therefore adopts a naturalistic, long-term, multi-domain observational design, an established approach in Earth system science and chronobiology.

Although this framework captures authentic system-level interactions, further progress may come from targeted "natural experiments" or semi-open field perturbations of environmental oscillations. Incorporating quantum-scale phase measurements into biological systems, while technically challenging, could provide direct empirical linkage between microphysical coherence and macrobiological dynamics.

Future research should prioritize the development of phase plasticity indices capable of predicting resilience and vulnerability to environmental fluctuations. Longitudinal mapping of phase network topology across health, disease, and recovery states may clarify thresholds, tipping points, and hysteresis effects that shape systemic trajectories (Alkhayuon

et al., 2021; Zhong et al., 2022). By emphasizing naturalistic, system-scale observation, this framework not only addresses experimental constraints but also extends to broader ecological contexts, where comparable phase-coherence principles govern non-human systems and biosphere-wide rhythms.

4.6 Broader Implications

The phase-coherence principles identified in this study are not confined to human physiology but extend across the biosphere, governing organismal rhythms in diverse ecological contexts. Preliminary field observations during evening atmospheric charge transitions revealed a striking acoustic phase switch in local insect populations. As atmospheric potential rose during the pre-sunset charging period, diurnal insect calls intensified in brief bursts lasting two to three minutes before subsiding, after which nocturnal insect calls emerged in synchrony. This crossover coincided with rapid changes in sky luminance and local magnetic micro-variations, suggesting that the transition was not solely light-driven but entrained to geophysical phase shifts within the magnetospheric–atmospheric plasma circuit. Such dynamics parallel the phase-switching phenomena observed in infectious disease states, supporting the view that environmental phase transitions act as universal organizing signals coupling neural, microbial, and ecological oscillators (Yousfi et al., 2023). Detailed recordings, including frequency spectrum analyses of acoustic patterns, are provided in the Appendix and underscore the translational relevance of phase principles across scales.

4.7 Cicada Emergence as a Discharge–Charge Phase Transition in the Bio–Atmospheric System

The present study advances an integrated bio–environmental–microbiome phase network model as a unifying framework for interpreting diverse pathological states. Across cancer, autoimmune disorders, infectious diseases, and metabolic syndromes, reproducible and condition-specific phase signatures were identified, corresponding to three distinct modes of oscillatory disruption: phase collapse, over-synchronization, and phase switching. Despite their differences, these patterns converge on a single organizing principle: the breakdown of resonance coherence across coupled physiological, microbial, and geophysical oscillators.

Geophysical oscillations, including geomagnetic variations and atmospheric potential shifts, were consistently linked to shifts in biological phase stability. Rather than acting as minor background influences, these external drivers repeatedly coincided with reorganizations of physiological and microbial phase networks. This situates disease expression within a multi-scale dynamical system governed by the same nonlinear physical laws that underlie abiogenesis. In this framework, the processes of life's emergence (phase locking) and its reorganization or dissolution (phase collapse/reset) can be interpreted as opposite trajectories along a shared physical continuum.

By framing pathology in terms of phase coherence loss, this model introduces novel diagnostic and therapeutic approaches. Continuous monitoring of multi-domain phase relationships may enable early detection of destabilizing trends, while interventions aimed at restoring cross-system coherence—through bioelectromagnetic entrainment, environmental rhythm modulation, or microbiome-phase reconfiguration—offer new preventive and restorative strategies. Furthermore, this naturalistic, system-scale approach provides a conceptual bridge between human health and planetary biosphere rhythms, emphasizing that the same phase-coherence principles apply from the cellular to the ecological scale. Such recognition positions health not as an isolated biological state but as an emergent property of an actively resonating Earth–life system.

5 Conclusion

This study advances and empirically substantiates an integrated bio–environmental–microbiome phase network model as a unifying framework for interpreting diverse pathological states. Across cancer, autoimmune disorders, infectious diseases, and metabolic syndromes, we identified reproducible and condition-specific phase signatures corresponding to three distinct modes of oscillatory disruption: phase collapse, over-synchronization, and phase switching. Despite their differences, these patterns converge on a single organizing principle: the breakdown of resonance coherence across coupled physiological, microbial, and geophysical oscillators.

Our findings demonstrate that geophysical oscillations, including geomagnetic variations and atmospheric potential shifts, are not peripheral modulators but primary determinants of biological phase stability. This perspective extends beyond reductionist biomedical paradigms, situating disease within a multi-scale dynamical system governed by the same nonlinear physical laws that underlie abiogenesis. In this view, the processes of life's emergence (phase locking) and its reorganization or dissolution (phase collapse/reset) are directionally opposite trajectories along a shared physical continuum.

By framing pathology in terms of phase coherence loss, this model enables novel diagnostic and therapeutic approaches. Continuous monitoring of multi-domain phase relationships may allow early detection of destabilizing trends, while interventions aimed at restoring cross-system coherence—through bioelectromagnetic entrainment, environmental rhythm modulation, or microbiome-phase reconfiguration—offer new preventive and restorative strategies. Furthermore, the

framework's scalability positions it as a conceptual bridge between human health and planetary biosphere stability, advancing a systems-level understanding of biological resilience.

A Evening Atmospheric Discharge Transition & Acoustic Phase Shift in Insect Populations

A.1 Observation Context

Observations were conducted during the evening of August 10 and the morning of August 11, 2025, in a hillside woodland in central Korea. The local sunset time on August 10 was 19:42 KST. Weather and atmospheric conditions were characterized by a clear sky, a light breeze, and stable temperature, with minor variations in atmospheric electric potential where measurable. The purpose of these observations was to examine the temporal synchronization between evening atmospheric discharge transitions and acoustic phase shifts in insect communities.

A.2 Visual Brightness Transition

Figure 3: Evening sky photographs (19:46–19:58) showing luminance transitions across three phases: brightness remained stable with cicada calls (Phase A, 19:46–19:51); gradual dimming occurred with overlap of cicada and night insect calls (Phase B, 19:51–19:55); and rapid dimming accompanied only by night insect calls (Phase C, 19:55–19:58).

A.3 Acoustic Transition

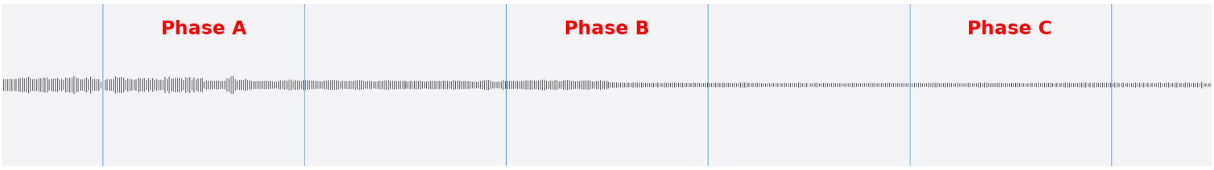

Figure 4: Acoustic waveform (19:46–19:58) highlighting soundscape transitions: cicadas dominated with periodic high-amplitude, high-frequency signals (Phase A); mixed contributions from cicadas and night insects produced overlapping frequency bands (Phase B); and night insects alone sustained low/mid-frequency tones (Phase C).

A.4 Phase Synchronization Diagram

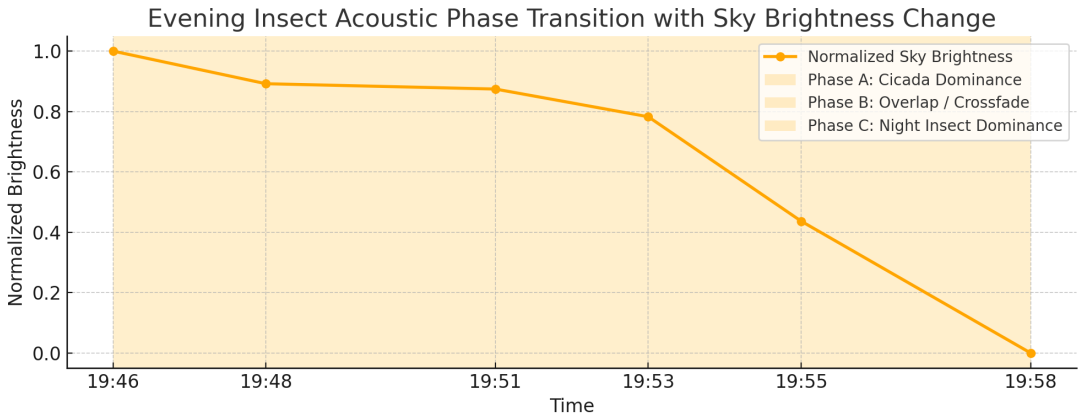

Figure 5: Normalized sky brightness plotted against acoustic phase transitions, showing cicada dominance during Phase A, overlap of cicada and night insect calls during Phase B, and exclusive night insect dominance during Phase C. The transition boundaries align with rapid luminance decreases, consistent with hypothesized atmospheric discharge shifts.

B Morning Burst Sequence

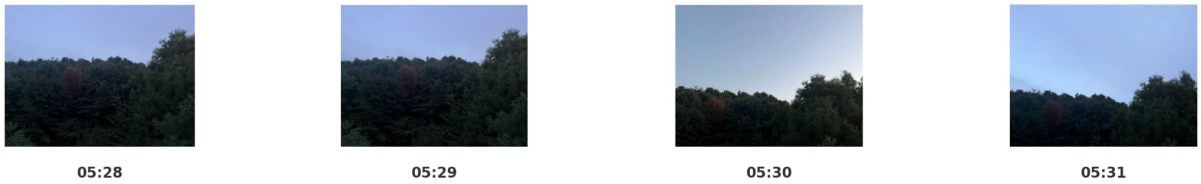

Figure 6: Pre-dawn sequence (05:28–05:31, 11 Aug 2025) showing sudden cicada acoustic burst followed by a shift to bird vocalizations and residual insect background.

Figure 7: Pre-dawn acoustic burst sequence recorded on 11 Aug 2025 in a hillside woodland in central Korea.
The sequence began at 05:28 KST with cicadas producing a high-intensity, short-duration burst (90 seconds), followed by a decline in amplitude as bird vocalizations rapidly emerged and dominated the soundscape.
Residual low-frequency insect tones persisted in the background.
This order contrasted with July 2025 observations at the same site, where birds preceded cicadas, suggesting seasonal or life-cycle-dependent inversion of calling order.
Such behavioral inversion parallels microbial succession dynamics, where taxa with stronger coupling to environmental charge–discharge cycles manifest phase shifts earlier than those with weaker coupling.

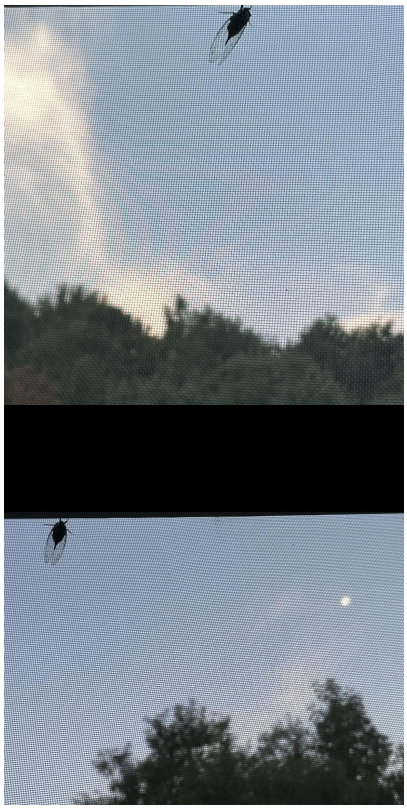

Figure 8: Pre-dawn cicada burst with concurrent moon–cloud plasma illumination (11 Aug 2025, hillside woodland in central Korea).
The burst began approximately 15 minutes before sunrise, peaked in amplitude for 1–2 minutes, and then rapidly faded, with bird vocalizations becoming dominant shortly afterward.
This suggests that cicada signaling is entrained not only to diurnal light transitions but also to atmospheric discharge-phase dynamics.

C Interpretation

The observed collective phase transition in insect acoustic patterns illustrates how environmental phase cues can entrain large-scale biological networks to shift state synchronously. Such behavior is not limited to insect populations; similar phase-switching dynamics can occur in microbial consortia within a host, as well as in cellular and tissue-level oscillatory networks. This example extends the scope of the phase–network framework discussed in the main text to the ecological scale, while also providing conceptual groundwork for understanding infectious-state transitions to be examined in the subsequent study.

Declaration

Availability of data and materials. All data and materials relevant to this study are included within the article. No additional datasets were generated or analyzed during the current study.

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