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Hypothesis

The Quantum Blueprint Formalism: An Informational Extension of Dissipative Quantum Field Theory in Living Systems

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Abstract

We propose a generalization of the dissipative quantum field theory (DQFT) of Ricciardi and Vitiello to describe the dynamic informational feedback underlying biological coherence. The new framework, termed the Quantum Blueprint Formalism (QBF), reinterprets the conjugate field ψ^\dagger not as a passive record of dissipation but as an active informational field that restores order through feedback coupling. A state-dependent dissipation operator $\Gamma(\psi, \psi^\dagger)$ couples the physical and informational domains through correlation parameters $\Theta = \{\theta_k\}$, which evolve in time according to a nonlinear stochastic differential equation. The resulting formalism quantitatively links informational coherence to physiological observables such as heart rate variability (HRV), EEG phase synchronization, water domain ordering, and ultraweak photon emission. This model establishes a bridge between dissipative quantum physics, information theory, and experimental biophysics, offering a consistent mathematical and empirical basis for understanding life as an informationally self-organizing process.

Keywords: quantum blueprint formalism; dissipative quantum field theory (DQFT); living systems

1. Introduction

Biological systems maintain long-range order far from thermodynamic equilibrium, continuously exchanging energy and information with their environment. Classical thermodynamics cannot account for such persistent coherence (Prigogine & Stengers 1984). To address this, Ricciardi and Vitiello (1987) formulated a dissipative quantum field theory (DQFT) based on Thermo Field Dynamics (TFD) (Umezawa 1967), wherein the Hilbert space is doubled to include both the system (ψ) and its conjugate (ψ^\dagger), representing the thermalized environment.

In this framework, coherence arises from spontaneous symmetry breaking and the condensation of Nambu–Goldstone bosons, producing macroscopic quantum domains that underlie perception, memory, and self-organization (Freeman & Vitiello 2006). However, in DQFT, ψ^\dagger functions only as a memory channel: it records the system's past interactions but exerts no direct causal feedback.

The Quantum Blueprint Formalism (QBF) extends this idea by assigning ψ^\dagger an active informational role. The conjugate field is no longer a passive sink but a dynamic attractor that reorganizes the physical system via informational feedback. This feedback is mediated by correlation parameters $\Theta = \{\theta_k\}$, representing coherence amplitudes between ψ and ψ^\dagger . Their dynamics define the organism's capacity to restore order following perturbation.

2. Mathematical Structure of the Quantum Blueprint Formalism

2.1. The Doubled Hilbert Space

In TFD, the state of an open quantum system is expressed as

$$|\Psi\rangle = |\psi\rangle \otimes |\psi^\dagger\rangle$$

and evolves under the total non-Hermitian Hamiltonian

$$H_{\text{total}} = H - H + i\Gamma$$

where the dissipative term $i\Gamma$ encodes irreversible energy flow between the two sectors.

DQFT ensures energy balance via

$$\langle \psi | H | \psi \rangle = \langle \bar{\psi} | H | \bar{\psi} \rangle.$$

In QBF, Γ becomes state-dependent:

$$H_{\text{total}} = H - H + i\Gamma(\psi, \bar{\psi}).$$

The operator $\Gamma(\psi, \bar{\psi})$ introduces bidirectional coupling that depends on instantaneous correlations between ψ and $\bar{\psi}$.

2.2. Ordered Vacua and Correlation Parameters

In both DQFT and QBF, ordered vacua $|0(\Theta)\rangle$ are parameterized by Bogoliubov transformations:

$$a_k(\theta_k) |0(\Theta)\rangle = 0 = \tilde{a}_k(\theta_k) |0(\Theta)\rangle$$

The modal occupation number is

$$N_k = \langle 0(\Theta) | a_k^\dagger a_k | 0(\Theta) \rangle = \sinh^2(\theta_k).$$

The overlap between vacua defines the correlation function

$$C(\Theta, \Theta') = \langle 0(\Theta') | 0(\Theta) \rangle = \prod_k [1/\cosh(\theta_k - \theta'_k)].$$

In QBF, a reference configuration Θ_{ref} is defined to represent the state of maximal coherence attainable by the system. Deviations $\Delta\theta_k = \theta_k - \theta_{k,\text{ref}}$ measure informational disorder.

2.3. Dynamical Evolution of Correlation Parameters

The time evolution of $\Theta(t)$ follows a dissipative–stochastic equation derived from the non-Hermitian Hamiltonian:

$$d\theta_k/dt = -\kappa_k(\theta_k - \theta_{k,\text{ref}}) + g_k h(t) + \sum_j \mu_{kj} F(\theta_k, \theta_j) + \eta_k(t)$$

where:

- κ_k is the intrinsic relaxation rate of mode k ;
- $g_k h(t)$ describes external perturbations (e.g., electromagnetic or thermal fields);
- $\mu_{kj} F(\theta_k, \theta_j)$ accounts for cross-mode coupling between correlated domains;
- $\eta_k(t)$ represents stochastic noise from environmental or quantum sources.

The first term drives the system toward its informational attractor Θ_{ref} , while the coupling matrix μ_{kj} introduces hierarchical coherence across scales.

The global coherence measure is given by the Blueprint Coherence Index (BCI):

$$\text{BCI}(t) = \exp[-1/2 \sum_k w_k (\theta_k - \theta_{k,\text{ref}})^2].$$

$\text{BCI} \in [0,1]$ quantifies the instantaneous informational alignment between ψ and $\bar{\psi}$.

3. Derivation from the Dissipative Lagrangian

Starting from the non-Hermitian Lagrangian density

$$\mathcal{L}_{\text{eff}} = \mathcal{L}(\psi) - \mathcal{L}(\bar{\psi}) + i\Phi(\psi, \bar{\psi}),$$

the Euler–Lagrange equations yield

$$\delta\mathcal{L}_{\text{eff}}/\delta\psi = 0, \quad \delta\mathcal{L}_{\text{eff}}/\delta\bar{\psi} = 0.$$

If Φ depends on the phase correlation between ψ and $\bar{\psi}$,

$$\Phi(\psi, \bar{\psi}) = \sum_k \kappa_k (\theta_k - \theta_{k,\text{ref}})^2/2 - \sum_j \mu_{kj} F(\theta_k, \theta_j),$$

then the variational derivative with respect to θ_k leads directly to

$$d\theta_k/dt = -\partial\Phi/\partial\theta_k + \eta_k(t),$$

which recovers the QBF dynamic equation.

Thus, QBF remains variationally consistent with the dissipative Lagrangian formalism and extends it by including an informational potential $\Phi(\psi, \bar{\psi})$.

4. Constructive Noise and Stochastic Resonance

The stochastic term $\eta_k(t)$ can be expressed as

$$\eta_k(t) = \xi_k \zeta(t)$$

with $\zeta(t)$ representing quantum noise (white or pink) and ξ_k its coupling amplitude. The response of mode k is characterized by its susceptibility

$$\chi_k(\omega) = g_k / [(\omega_k^2 - \omega^2) + i \gamma_k \omega].$$

When the spectral density $S_{\eta}(\omega)$ overlaps with $|\chi_k(\omega)|^2$, noise enhances coherence — a phenomenon known as stochastic resonance (McDonnell & Ward 2011). This mechanism explains how biological systems can exploit fluctuations to maintain order near criticality.

5. Formal Comparison with Vitiello's DQFT

Aspect	DQFT (Vitiello)	QBF (Schmieke)
Hilbert space	Doubled:	ψ ,
Hamiltonian	$H_{\text{total}} = H - H + i\Gamma$ (Γ constant)	$H_{\text{total}} = H - H + i\Gamma(\psi, \psi)$ (state-dependent)
Order parameters	$\theta_k =$ Bogoliubov angles (memory codes)	$\theta_k =$ informational coherence variables
Dynamics	Static symmetry breaking	Dynamic feedback with Θ_{ref} attractor
Noise	Decoherence	Constructive stochastic resonance
Consciousness	Emergent phenomenon	Intentional modulation term $I(t)$ possible
Observables	Theoretical only	Empirically measurable via HRV, UPE, EEG

6. Empirical Correspondence and Testability

The QBF provides quantitative links between theoretical parameters and measurable physiological observables.

Theoretical variable	Empirical observable	Method
$\Delta\theta_k = \theta_k - \theta_{k,\text{ref}}$	HRV phase deviation	Fourier and wavelet HRV analysis
BCI(t)	HRV coherence index	0.1 Hz spectral power ratio (Shaffer & Ginsberg 2017)
ψ feedback	Ultraweak photon emission (UPE)	Biophoton photomultiplier counts (Popp 1992; Van Wijk 2014)
$\chi_k(\omega)$	EEG phase coherence, dielectric spectroscopy	FFT/PSD methods
$\eta_k(t)$	Controlled noise input or QRNG modulation	Correlation and entropy measures
Θ_{ref} drift	Longitudinal HRV + photonic correlations	Week-to-week BCI trajectory

6.1. HRV and Systemic Coherence

Heart rate variability reflects the organism's capacity for self-regulation. Within QBF, HRV coherence corresponds to convergence of the low-frequency (~0.1 Hz) oscillatory mode toward its Θ_{ref} . High BCI(t) values correlate with stable 0.1 Hz oscillations (Shaffer & Ginsberg 2017).

6.2. EEG Coherence

EEG phase synchronization represents high-frequency analogues of θ_k dynamics in neural domains. Periods of sustained alpha or gamma synchronization correspond to temporary increases in ψ - ψ alignment.

6.3. Water and Dielectric Spectroscopy

Experimental work by Del Giudice and Pollack (2013) suggests that structured water forms coherent domains at infrared frequencies. Dielectric phase measurements reveal dynamic order consistent with correlated θ_k modes.

6.4. Ultraweak Photon Emission (UPE)

Biophotons, as observed by Popp (1992) and Van Wijk (2014), display coherence signatures that reflect ψ feedback. Temporal correlations in photon count distributions could serve as experimental proxies for $\Delta\theta_k$ dynamics.

7. Discussion

7.1. Informational Feedback and Self-Organization

The central innovation of the Quantum Blueprint Formalism lies in treating the conjugate field ψ as an *informationally active feedback partner* rather than a passive record of dissipation. In standard dissipative quantum field theory, the exchange term $i\Gamma$ enforces energy balance between ψ and ψ but does not carry explicit information about the system's past coherence. In the QBF, $\Gamma(\psi, \psi)$ depends on their instantaneous correlation structure $\Theta(t)$, producing a self-referential dynamics in which information about coherence loss simultaneously provides the conditions for its recovery. This mechanism mathematically formalizes the long-suspected self-healing capacity of living matter: coherence is not simply maintained by external energy input, but by a continuous *informational recursion* between physical and conjugate domains.

The presence of an informational potential $\Phi(\psi, \psi)$ establishes a bidirectional feedback loop, transforming the dissipative decay equations into adaptive homeodynamic equations. The relaxation constant κ_k defines the speed of restoration for each mode, while the coupling matrix μ_{kj} encodes cooperative or competitive interactions among modes. The resulting dynamics are comparable to coupled order-parameter systems in complex condensed-matter physics but differ in that the restoring force originates not from a mechanical potential, but from an *informational attractor* Θ_{ref} that embodies the history of the system's coherent configurations.

7.2. Connection to Open-System Thermodynamics

The informational feedback implied by QBF is consistent with nonequilibrium thermodynamics and the concept of *dissipative structures* (Prigogine & Stengers 1984). The informational field ψ effectively functions as a low-entropy reservoir that stores correlation information rather than energy. The system therefore minimizes its informational free energy rather than its energetic free energy, a principle reminiscent of Friston's "free-energy principle" in neuroscience, but derived here from first principles in quantum field dynamics. The attractor Θ_{ref} may thus be understood as the instantaneous configuration minimizing the informational free-energy functional

$$F_{info}(\Theta) = \frac{1}{2} \sum_k \kappa_k (\theta_k - \theta_{k,ref})^2 - \sum_{kj} \mu_{kj} F(\theta_k, \theta_j).$$

This perspective situates the QBF squarely within the physics of *informational thermodynamics*, where order and meaning emerge as physical invariants of open quantum systems.

7.3. Relation to Quantum Biology

A number of experimental findings in quantum biology resonate with the assumptions of the QBF. Long-range coherence in hydrated biomolecules (Fröhlich 1968), collective dipole oscillations in water (Del Giudice et al. 1988), and coherent energy transfer in photosynthetic complexes all exemplify stable coherence under dissipative conditions. These phenomena suggest that living matter operates close to critical points where small informational perturbations can reorganize macroscopic order. The feedback mechanism $\psi \leftrightarrow \psi$ provides a plausible mathematical foundation for this critical adaptability.

Furthermore, the stochastic-resonance term $\eta_k(t)$ offers a framework for interpreting the beneficial role of biological noise observed in neural, cardiac, and genetic systems (McDonnell & Ward 2011). Instead of disrupting coherence, noise can modulate the effective susceptibility $\chi_k(\omega)$ of coherence modes, enabling adaptive synchronization. The QBF thus integrates coherence, noise, and self-organization into a single dynamical principle.

7.4. Empirical Perspectives

While fundamentally theoretical, the QBF is testable through observable correlates of informational coherence. Heart-rate-variability coherence (Shaffer & Ginsberg 2017) reflects slow global oscillations (≈ 0.1 Hz) associated with high BCI(t). EEG phase synchronization represents faster local coherence dynamics corresponding to individual θ_k modes. Ultraweak photon emission (Popp 1992; Van Wijk 2014) and dielectric relaxation of water (Pollack 2013) may serve as proxies for ψ feedback processes. Together, these measurements could enable experimental estimation of the parameters κ_k , μ_{kj} , and $\eta_k(t)$ and permit empirical mapping of the system's informational phase trajectory $\Theta(t)$.

Such an integrative approach would transform the study of living coherence from qualitative speculation into quantitative modeling, allowing explicit tests of whether coherence restoration follows the predicted exponential convergence toward Θ_{ref} and whether noise indeed enhances rather than degrades BCI(t).

7.5. Conceptual Implications

By redefining dissipation as a channel for information flow, the QBF reframes life not as a thermodynamic anomaly but as a lawful outcome of open-system physics. The conjugate field ψ becomes the mathematical representation of *context*: the total information of the organism's past interactions that continuously informs its present structure. In this view, coherence, adaptation, and even memory are not separate biological functions but emergent properties of the same informational coupling that underlies all living systems.

8. Conclusions

The Quantum Blueprint Formalism (QBF) extends the dissipative quantum field theory of Ricciardi and Vitiello by introducing an explicit informational feedback mechanism between the physical and conjugate sectors of the doubled Hilbert space. The reformulation of the dissipation operator Γ as a state-dependent functional of ψ and ψ leads naturally to a set of dynamical equations for the correlation parameters $\Theta = \{\theta_k\}$, describing how coherence is lost and regained in time. The introduction of an informational attractor Θ_{ref} transforms the theory from a model of memory preservation into a model of *self-restoring coherence*.

Mathematically, the QBF remains consistent with the variational structure of dissipative field theory but expands its descriptive power through the informational potential $\Phi(\psi, \psi)$ and the Blueprint Coherence Index BCI(t). Physically, it provides a bridge between quantum field dynamics, open-system thermodynamics, and information theory. Biologically, it offers a unifying explanation for coherence phenomena observed across molecular, cellular, and systemic scales.

The QBF suggests that living systems operate as *informational oscillators* coupled to their own conjugate fields, continually regenerating order through the feedback of structured information. This insight reframes the classical dichotomy between matter and information: matter appears as the transient projection of an underlying informational process, and life emerges as the perpetual dialogue between the two.

Future research should aim to (1) derive the full QBF equations from a generalized non-Hermitian Lagrangian, (2) determine experimentally the empirical signatures of ψ - ψ coupling through HRV, EEG, dielectric, and photonic measurements, and (3) explore whether the informational potential Φ can be related to entropy production or algorithmic information content. If

confirmed, the Quantum Blueprint Formalism may provide the missing physical basis for understanding biological coherence, adaptability, and the continuity between physics, information, and consciousness.

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