Article

The Singularity at the Heart of Evolutionary Biology: Organismal Selection and the Thermodynamic Origin of Life

Innocent Ouko*

Aga Khan University

*Corresponding Author: innoholmes@gmail.com

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Abstract

The origin of the first organism presents as a fundamental discontinuity in evolutionary biology. While population-centred theories of natural selection succeed when reproduction and heredity exist, they cannot explain life's emergence from non-living matter. Building on the conceptual framework of Organismal Selection, this work proposes a physical model in which the transition from lifeless ensemble to living system is described as a singularity in probability space, a critical point where dissipation becomes self-referential. We demonstrate how persistent bias toward survival, quantified by the informational term β, arises when the energy flux Φ exceeds a critical value Φ^*, resulting in self-referential persistence. This bias redirects entropic flow, transforming diffusive decay into a self-organising attractor in state space. This thermodynamic reinterpretation unifies dissipative-structure theory and evolutionary biology, positing organismal persistence rather than reproduction as the primitive selection criterion. The model further predicts measurable thresholds in energy flux and information sensitivity, offering a testable horizon for origin-of-life research.

1. Introduction

1.1 The limits of population-centered evolutionary theory

Modern evolutionary biology is founded on population-level mechanisms. Natural selection, originally conceived by Darwin[1] and mathematically formalized in the Modern Synthesis[2], requires variation among replicating individuals within populations. Evolution, in this view, is a statistical process acting on the distribution of heritable traits across many organisms. While the theory successfully accounts for adaptation and diversification, it remains ill-equipped to explain the origin of the first organism.

The difficulty lies in the fact that all major evolutionary theories, such as classical population genetics, molecular evolution, and even contemporary extensions, such as the Extended Evolutionary Synthesis[3], presuppose an existing number of replicators, although the concept of replicators has its own shortfalls [4]. Fitness, selection coefficients, and inheritance are defined only in terms of population frequencies. When the system consists of only non-replicating chemical aggregates, these theories lose explanatory power. The “first organism” is hardly a population from this statistical viewpoint. It becomes an exception, a discontinuity where the standard equations of evolutionary dynamics cannot operate.

1.2 The prebiotic problem and the need for a physical first principle

Attempts to bridge this gap often turn to prebiotic chemistry. Examples such as autocatalytic networks[5,6] or metabolic-first models[7] versus replication-first models [8]often compete to win the explanatory bounty. These approaches describe plausible chemical pathways but do not specify *why* certain configurations of matter cross the threshold into self-preservation while others dissolve back into equilibrium. They therefore account for *possibility*, but not *necessity*. Thus, the question remains: what physical principle governs the transition from disordered chemical ensembles to a structure that behaves like an organism?

If the emergence of life was not a statistical accident but a lawful outcome of thermodynamic processes, then it must be possible to express this transition as a dynamical property of physical systems. Jeremy England was perhaps the first to attempt to conclusively solve this problem with the concept of dissipative-adaptation [9]. We show that there is a deeper structure, emphasizing the origin of the first organism, and how it expounds on the concepts already described by England. Should we succeed in developing such a model, our understanding of the possibility of life-forms outside our galaxy should also gain a different layer of possibility. This requires a framework that does not presuppose replication or heredity, as they are traits that formed after the first organism came into existence. Instead, we shall need one that defines selection and persistence from a point of intrinsic physical biases.

1.3 Organismal Selection as the conceptual bridge

In previous work[10], a new principle known as Organismal Selection was proposed to address this deficiency. The theory redefines selection as a process acting primarily on an individual rather than on populations of replicators. Genes and the idea of replicators are hosted inside organisms, and species are phylogenetically identified by lineages. An organism, qua Organismal Selection, is defined by its degree of thermodynamic persistence. Persistence, logically converted into a probability value, is the capacity to resist annihilation within a fluctuating energy landscape, preserving its integrity over time. Organismal Selection thus posits that selection emerges wherever a system develops a bias toward preserving its internal configuration.

Unlike classical selection, which operates retrospectively on the differential survival of offspring, Organismal Selection acts instantaneously on the thermodynamic structure of the organism itself. It provides a foundational chassis for understanding how selection can exist prior to reproduction, offering a solution to the origin problem that evolutionary population models cannot resolve.

1.4 Toward a physical model of organismal emergence

The present work proposes a formal description of the emergence of organisms. We show how the transition from non-living to living matter can be described as a singularity in probability space, to create a point at which the statistical distribution of physical states becomes infinitely biased toward persistence. Thermodynamically, this corresponds to points where ordinary diffusion-driven dynamics give way to self-localizing, self-referential behavior.

By deriving a singular evolution operator governed by an informational bias term (β), we demonstrate how the core idea of Organismal Selection arises naturally from statistical physics. The resulting framework unifies the continuity of physical law with the apparent bounded discontinuity of biological emergence, treating life as a phase of matter defined by its maximal bias toward survival.

2. The Evolutionary Singularity Hypothesis

2.1 From physical to biological singularities

In physics, a singularity marks a point at which the governing equations break down, signaling a transition into a new regime, such as the infinite curvature of spacetime at the center of a black hole [11,12], or the initial cosmic singularity at the Big Bang or Big Bounce [13].

Although typically treated as continuous, biological evolution contains an analogous discontinuity: the origin of the first organism. Before this transition, no selection, heredity, or reproduction exists. Beyond it, the full machinery of Darwinian evolution operates. This conceptual break mirrors the mathematical structure of a physical singularity, since the known equations of population genetics cease to apply.

The Evolutionary Singularity Hypothesis proposed here interprets this transition as a *thermodynamic and informational singularity*: a point where the probability distribution governing matter's configurations becomes infinitely biased toward persistence, giving rise to the first self-referential system.

2.2 The probabilistic structure of persistence

Let a physical system be represented by a probability density $\rho(x,t)$ over its microstates x in configuration space. In the absence of organizing forces, ρ evolves diffusively under entropy maximization:

$$\frac{\partial \rho}{\partial t} = \nabla \cdot (\mathrm{D} \nabla \rho) \qquad (1)$$

where D is an effective diffusion coefficient describing stochastic energy exchange with the environment.

However, empirical living systems do not simply diffuse toward equilibrium. They maintain and reproduce specific low-entropy configurations. To describe this, we introduce a bias term β that modifies the entropy-production rate:

$$\frac{dS}{dt} = \sigma + \beta \tag{2}$$

with σ representing spontaneous entropy generation and β an informational contribution favoring persistence.

In a purely physical system, $\beta=0$. In a system capable of adaptive persistence, $\beta>0$, expressing an asymmetric probability flow toward configurations that resist decay.

At the singularity, this asymmetry diverges: $|\beta| \to \infty$. At this limit, the system's probability distribution collapses into a narrow region of state space corresponding to the first *organismic* configuration, arriving at matter that statistically favors its own continuation in an energy landscape.

Let's take Φ to be the total energy flux available to or processed by a system. It governs how much of the probability space a system can explore. As Φ increases, the accessible regions of state spaces increase, improving the chance of reaching highly organized, low entropy states. Thus, at a critical Φ^*, a phase transition occurs. When $\Phi < \Phi^*$, normal chemistry dominates, but when $\Phi \geq \Phi^*$, organismic properties emerge spontaneously even without the known biological machinery. At this point of divergence, the bias term β emerges, introducing the transition of persistence-driven dynamics. Thus, β is a function of Φ, growing sharply as $\Phi \to \Phi^*$.

2.3 Thermodynamic interpretation of the singularity

From a thermodynamic perspective, the evolutionary singularity represents the moment when energy dissipation becomes self-referential. Prior to this point, dissipation is passive: gradients decay irreversibly without memory. Beyond it, dissipation becomes organized: the system channels energy to maintain the very structure through which dissipation occurs.

A change in the sign of the entropy gradient with respect to configuration probability can characterize this transition:

$$\frac{\delta S}{\delta \rho(x)} > 0 \quad (\mathrm{pre-organismic\ regime}) \tag{3}$$

$$\frac{\delta S}{\delta \rho(x)} < 0 \quad (\mathrm{post-organismic\ regime}) \tag{4}$$

The sign change implies a feedback loop: entropy production now reinforces structural integrity instead of eroding it. The singularity thus corresponds to the *bifurcation point* where the thermodynamic flow becomes self-stabilizing.

2.4 Connection to Organismal Selection

Within the framework of Organismal Selection[10], every organism is viewed as a self-maintaining statistical configuration that selects its own persistence conditions from within the surrounding probability field.

The evolutionary singularity hypothesis formalizes this principle physically. At the singularity, the differential persistence probability

$$P_{persistence} = \int_{\Omega \text{viable}} \rho(x,t)dx \tag{5}$$

dominates the annihilation probability, producing an intrinsic bias term

$$\beta = k_B ln\left(\frac{P_{persistence}}{P_{annihilation}}\right) \tag{6}$$

When $P_{persistence} > P_{annihilation}$, β becomes large and positive, quantifying the intrinsic "will to persist" that corresponding to the birth of organismal individuality. Notably, these probabilities are cumulative survival probabilities integrated over the system's lifetime.

This mechanism provides the physical substrate of Organismal Selection. It further highlights the method of seeking mergers to improve organismal persistence, since assigning organisms probabilities of persistence improves their β. The equation introduces a self-consistent probability asymmetry that drives systems toward organized survival even in the absence of reproduction or population structure.

2.5 Toward a formal dynamical expression

To describe this process quantitatively, we define a singular evolution operator that combines diffusion and exponential persistence bias:

$$\frac{d\rho}{dt} = \nabla \cdot (D\nabla\rho) + \beta\rho \tag{7}$$

The first term represents ordinary diffusion; the second, exponential amplification of persistent configurations. This equation resembles that of reaction-diffusion[14], but with exponential selection.

At equilibrium ($\beta=0$), the system relaxes to uniform probability. At the singularity ($\beta \to \infty$, $D \to 0$), the system localizes, forming a stable, self-sustaining structure, serving as a mathematical signature of the first organism.

This operator bridges the gap between thermodynamics and biology, showing that the onset of organismal behavior is not an exception to physical law but a critical transition within it.

The Evolutionary Singularity Hypothesis thus reframes the origin of life as a phase transition in probability space. That is, the point where diffusion-dominated dynamics give way to persistence-dominated dynamics. It provides the physical mechanism underlying Organismal Selection, explaining how selection can operate *without* pre-existing populations.

3. The Thermodynamic Basis of Organismal Persistence

3.1 Entropy flow and the emergence of persistence

All physical systems evolve according to the second law of thermodynamics, tending toward maximum entropy. Life, on the contrary, presents a local reduction of entropy that persists over time despite the external global entropy increase. This apparent contradiction has long been reconciled by invoking open-system thermodynamics, whereby organisms maintain order by exporting entropy to their surroundings [15,16].

However, this explanation remains descriptive rather than generative. It tells us *how* life maintains itself once organized, but not *why* such self-organizing configurations emerge in the first place. The evolutionary singularity flips this question, and in keeping with the second law of thermodynamics, shows how it arises naturally wherever the dissipation of energy becomes statistically coupled to the retention of structure.

In this view, the entropy flux through a system is not uniform: certain configurations preferentially channel energy in ways that sustain their own existence. The appearance of such a configuration marks the singular transition, marking a shift from passive dissipation to *self-referential dissipation*. Life thus emerges as a critical point where entropy production becomes biased toward maintaining the conduit through which it flows.

3.2 Dissipative structures and organismal identity

Prigogine's theory of dissipative structures describes how open systems driven far from equilibrium can spontaneously develop ordered states[16,17]. He gives the examples of convection cells, chemical oscillations, or reaction–diffusion patterns[14] that persist by dissipating energy gradients. Living systems extend this logic with a crucial difference: through a unique hereditary identity, they encode and replicate the conditions for their persistence.

The concept of Organismal Selection arises precisely here. Each organism is a dissipative structure that locally maximizes its persistence probability by reorganizing internal flows to actively maintain its boundary integrity. An organism is a local attractor of the entropy landscape, sustaining a configuration that stabilizes itself against abounding and evolving energy fluctuations.

The evolutionary singularity marks the first time such an attractor appears. Before it, dissipation is isotropic and transient. After it, dissipation can become path-dependent and potentially heritable. Persistence ceases to be a mere physical accident and becomes an intrinsic property of the system's dynamics.

3.3 Persistence as a thermodynamic invariant

Recall that Φ denotes the total energy flux through the system. Let $\dot{S}_{int}$ and $\dot{S}_{ext}$ represent the internal and external rate of entropy change, respectively. In open systems,

$$\frac{dS_{total}}{dt} = \dot{S}_{int} + \dot{S}_{ext} \geq 0 \tag{8}$$

For ordinary physical systems, $\dot{S}_{int} > 0$, corresponding to structural decay. For living systems, however, $\dot{S}_{int} < 0$: internal entropy decreases while external entropy increases.

At the singularity, the balance point occurs where:

$$\dot{S}_{int} + \dot{S}_{ext} = 0 \tag{9}$$

marking the onset of *sustained nonequilibrium*. This condition defines the thermodynamic invariant of organismal persistence: the configuration where the rate of entropy export precisely offsets internal entropy accumulation.

The formula shows that such systems are metastable, continually renewing themselves through dissipation. They exist at the edge of chaos, defining a state sustained by a continuous flow of energy and information. Importantly, this is not a static but a flow equilibrium, sustained by a continuous flux of energy and information. This persistent self-referential flow constitutes the thermodynamic identity of the organism.

4. Implications for Evolutionary Theory

4.1 The discontinuity in evolutionary frameworks

Modern evolutionary biology successfully explains adaptation and diversification among existing organisms, but it relies fundamentally on population-based mechanisms, through differential survival and reproduction among replicators. Descent with modification[18]. These models, however, encounter a fundamental discontinuity at the origin of life. They cannot describe the prebiotic transition because their mathematics presupposes the very properties of inheritance, variation, and reproduction, which they seek to explain. From these theories, the first organism is an inexplicable anomaly or a statistical miracle rather than an outcome in keeping with universal laws.

The evolutionary singularity resolves this paradox by grounding selection in thermodynamic persistence rather than reproductive success. It formalizes *selection without reproduction*, operating through the physical asymmetry between annihilation and persistence. This transforms the origin of life from an exception to a predictable outcome of energy flow through complex matter. Persistence emerges first. Reproduction evolves later as a powerful strategy for extending it.

4.2 Reconciling physics and biology through Organismal Selection

Organismal Selection provides the missing bridge between thermodynamics and evolutionary theory. It sets aside the concept of an organism as a unit in population statistics and repositions it as a *statistical attractor* in energy–information space. The probability of persistence replaces reproductive fitness as the fundamental measure of evolutionary success.

The evolutionary singularity hypothesis unites three levels of description into a uniform physical-biological narrative:

1. **Physical** — energy gradients and entropy flow determine possible configurations.
2. **Thermodynamic** — beyond the critical energy flux (($\Phi > \Phi^*$) dissipation becomes self-referential, stabilizing specific structures at the singularity.
3. **Biological** — persistence manifests as adaptation and evolution once replication evolves. Replication is therefore a strategy of persistence, but not the only one.

Through this continuity, the apparent discontinuity between life and nonlife dissolves. Evolution becomes a universal statistical process operating across scales, as previously described elsewhere [10], from the emergence of the first dissipative structures to the complexity of modern ecosystems. Replication emerges as the most potent refinement of persistence.

4.3 Expanding the domain of selection

By decoupling selection from reproduction, the framework of Organismal Selection broadens the scope of evolutionary theory. It allows us to ask: What other forms of “evolution” might occur in systems capable of persistence but not replication? This perspective invites application to:

1. **Prebiotic chemical systems** approaching the critical flux Φ^*,
2. **Non-replicating but persistent complex structures** (e.g., Jupiter’s red spot [19]),

- **Hypothetical non-terrestrial life** where propagation may not rely on nucleic-acid-like heredity.

In each case, the measure of success ceases to be the number of copies. It now becomes the duration and stability of a self-maintaining organization, a criterion fully expressible in thermodynamic and informational terms.

4.4 Toward a new synthesis

The evolutionary singularity hypothesis, anchored in Organismal Selection, suggests a step toward a Physical Synthesis of Evolution. It creates a foundation that begins with the thermodynamics of individual persistence. Populations come later. Such a synthesis does not contradict Darwinian logic. Rather, it provides its physical foundation and extends its domain backward to life's very emergence. It positions biology as a different phase of the same science, as the study of matter in its most persistently self-organizing phase.

5. Empirical Horizons and Testable Predictions

The formal model presented in Appendix 2 defines measurable parameters (Φ^*, β) that allow the transition of the Evolutionary Singularity Hypothesis from a theoretical framework to an empirically testable one.

5.1 The Critical Flux (Φ^*) Threshold

Life does not emerge through gradual accumulation. Our understanding of complexity might give the impression of a gradual buildup, which may not necessarily be untrue, since water builds up to 100 °C to start boiling at that point when it transitions from liquid to gas. Our model shows precisely such a transition occurs when the external energy flux (Φ) crosses a critical value (Φ^*). The following predictions are an extension of the concept we have described here:

1. **Flux-Driven Phase Transition**: Laboratory simulations of prebiotic chemistry, when driven by $\Phi < \Phi^*$, will exhibit only transient, diffusive dissipative structures. A sudden, non-linear emergence of a self-maintaining, persistent structure (satisfying the Non-Equilibrium Steady State condition in Eq. 2.1 in Appendix 2) will occur as Φ is increased past Φ^*. Such effects should be observable in protocell systems such as lipid–RNA assemblies, redox-driven droplets, or UV/thermal cycling experiments [20–23].
2. **Thermodynamic Material Constant**: The critical threshold Φ^* is not universal but depends on the chemical composition and temperature (T). Φ^* arises from the material-specific dissipation function Ψ (Eq. 2.1 from Appendix 2), suggesting that Φ^* is inversely related to the inherent stability of the molecular precursors (less stable precursors require higher Φ^*). Relevant thermodynamic analyses support material-dependent thresholds [24].

5.2 Quantifying Organismal Bias (β)

The β parameter quantifies the self-referential, information-driven restoration dynamics of the organismic state, with the following predictions:

1. **Measurement of Self-Referential Dissipation:** In the post-singularity regime ($\Phi \geq \Phi^*$), β can be experimentally determined by measuring the energy cost or relaxation time (τ), which is the characteristic time required for the system to recover its configuration x_{org} after a small entropy-inducing perturbation. This recovery energy represents the work done by the informational flow ($\beta\rho$) to resist diffusive decay ($D\nabla\rho$) (Eq. 2.2 from Appendix 2). Methods from nonequilibrium relaxation spectroscopy may serve as analogues [25–27].

2. **Sharp Probabilistic Localization**: High-resolution spatial imaging of prebiotic ensembles driven near Φ^* should detect an abrupt, nonlinear localization of chemical species as $\beta\rho$ overpowers $D\nabla\rho$. This transition should correlate with the emergence of proto-compartmentalized boundaries or structural integrity [28,29].

6. Conclusion: Life as a Thermodynamic Singularity

Life does not defy physics. The Evolutionary Singularity Hypothesis, along with Organismal Selection, reveals that the transition from nonliving to living matter can be understood as a critical thermodynamic event: a point at which entropy production becomes intrinsically biased toward the persistence of structure.

At that singular moment when energy flux crosses the critical threshold Φ^*, probability ceases to be neutral. A fundamental asymmetry appears. The universe develops its first preference, an organism, as a statistical asymmetry in favor of persistence. From this, the logic of evolution unfolds naturally. Replication, variation, heredity, adaptation are all successive elaborations of that initial physical bias towards self-persistence.

The organism emerges as the inevitable expression of the universe's tendency to preserve complexity when driven far from equilibrium. It's not order for free; it's a push to preserve the order. Life is the singular point at which matter learns to persist. The search for life elsewhere in the cosmos, and for its earliest traces on Earth, may now be guided by a fundamental principle: look for the conditions where persistence becomes inevitable.

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Appendix 1: Relation to Prior Thermodynamic Frameworks

Jeremy England's dissipative adaptation framework (2013–2020) represents one of the most compelling recent attempts to explain life's emergence using nonequilibrium statistical mechanics. Building on the Crooks and Jarzynski fluctuation theorems, England demonstrated that driven physical systems are statistically biased toward configurations that dissipate energy more effectively. Under periodic forcing, such systems "learn" efficient energy-dissipation pathways through the accumulation of microscopic irreversibilities. In this sense, adaptation is treated as a statistical outcome of thermodynamic necessity, independent of biological heredity or replication.

While the evolutionary singularity hypothesis model shares this thermodynamic foundation, it differs in three critical respects: causality, topology, and ontology.

1. Causality: External selection vs Internal Self-Reference

England's model is externally driven. Dissipation increases because the environment continuously injects energy, selecting efficient configurations from outside. In contrast, Organismal Selection is internally driven: persistence emerges when dissipation becomes *self-referential*. The informational bias term (β) quantifies how much a configuration's entropy production feeds back into maintaining its own structure. Here, the system does not merely respond to environmental forcing. Rather, it actively modifies its own probability landscape, acting as both the object and subject of selection. The bias is a testament to the value of agency in the evolution of organisms.

2. Topology: Gradual Adaptation vs Singular Transition

Whereas England's framework describes a gradual adaptation across state space, the present theory identifies a singularity in probability space, a critical transition at which informational curvature diverges and the system collapses into a stable attractor. This evolutionary singularity marks the point where entropy flow stops being passive and becomes autocatalytic, generating the first persistent organization that satisfies the balance condition (Eqn 9). Dissipative adaptation thus transitions into organismal persistence at a well-defined threshold.

3. Ontology: Efficient Dissipator vs. Self-Referential Individual

In England's interpretation, life is a statistical inevitability, an emergent property of driven matter optimizing entropy production. Life is regarded as an efficient dissipator. The stronger claim proposed by the evolutionary singularity hypothesis is that, besides being an efficient dissipator, life is a self-referential discontinuity in the probabilistic fabric of the universe. It is the point where physics begins to *conserve itself through form*. The organism thus becomes the first natural expression of physical self-reference.

Summary

Both frameworks locate life within the laws of nonequilibrium thermodynamics. Yet while England's dissipative adaptation shows how matter *comes to resemble life*, the evolutionary singularity explains why such resemblance stabilizes into individuality. It extends the former's logic from adaptation to persistence, or in a more poetic way, from physics discovering life to life emerging as physics discovering itself.

Appendix 2: Formal Derivation of the Evolutionary Singularity

This appendix formalizes the emergence of the critical energy flux (Φ*) and the informational bias term (β) from nonequilibrium thermodynamics, providing a rigorous basis for the singular evolution operator.

2.1 The Critical Energy Flux (Φ*) as a Non-Equilibrium Steady State Invariant

The onset of the organismic state is defined by the moment the system achieves a Non-Equilibrium Steady State (NESS) through self-maintenance, satisfying the condition for thermodynamic persistence. The total entropy change is:

$$\frac{dS_{total}}{dt} = \dot{S}_{int} + \dot{S}_{ext} \geq 0 \quad (\text{Eq.} \, 8)$$

The internal entropy production $\dot{S}_{int}$ (always ≥ 0) is proportional to the Onsager dissipation function Ψ in the system's configuration x:

$$\dot{S}_{int} = k_B \cdot \Psi(x, J)$$

where $\Psi = \sum_i J_i X_i$ and represents the irreversible processes [30]driven by the total flux Φ.

The external entropy exchange is approximated as:

$$\dot{S}_{ext} \approx -\frac{\Phi}{T}$$

because incoming energy flux corresponds to exported entropy.

The Critical Flux Φ* is defined when $\frac{dS_{total}}{dt} = 0$, corresponding to:

$$k_B \cdot \Psi(x_{org}, J) = \frac{\Phi}{T}$$

with X_{org} denoting the emergent organismal configuration.

Φ* is the minimum flux at which internal dissipation is exactly balanced by exported entropy.

Below Φ*, no persistent NESS is possible.

2.2 Derivation of the Singular Evolution Operator

The probability density ρ(x, t) evolves according to:

$$\frac{\partial \rho}{\partial t} = -\nabla \cdot (J_{diff} + J_{info})$$

When $\Phi \geq \Phi^*$, the system produces an informational potential V_β:

$$V_\beta(x) \propto k_B . \ln \left(\frac{P_{persistence}(x)}{P_{annihilation}(x)}\right) \text{ [27], (based on Eq.6)}$$

The resulting informational flux is:

$$J_{info} = -\rho . \nabla V_\beta$$

Combining diffusive and informational fluxes gives:

$$\frac{\partial \rho}{\partial t} = \nabla . (D \nabla \rho) + \nabla . (\rho \nabla V_\beta)$$

Near x_{org}, V_β is sharply peaked, so:

$$\nabla . \rho \nabla V_\beta \approx \beta \rho$$

where β is the local probabilistic amplification rate, zero for $\Phi < \Phi^*$ and positive for $\Phi \geq \Phi^*$.

This yields the Singular Evolution Operator (Eq. 7):

$$\frac{d\rho}{dt} = \nabla \cdot (D\nabla\rho) + \beta\rho$$

The Evolutionary Singularity occurs when $\Phi \rightarrow \Phi^*$, causing β to become sharply positive and dominate diffusion, collapsing ρ into the organismic attractor x_{org}.