

Preface to the Trilogy on the Principle of Dynamical Sensitivity: Nature, Scope, and Intended Reading

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This document serves as a preface to the trilogy listed below. It is recommended that this preface be read before Papers I–III, as it clarifies the nature, scope, and intended reading of the trilogy as a whole. The trilogy should not be approached as a claim of new physical laws or a complete predictive theory, but as a philosophical-physical synthesis that proposes a new interpretive perspective drawing on established dynamical tools.

1. Nature and Purpose of this Document

This preface accompanies the following trilogy of preprints by Martin Kafara: (1) The Principle of Dynamical Sensitivity of Structures within a Shared Physical Environment (DOI: 10.5281/zenodo.18895255), (2) Operationalizing the Principle of Dynamical Sensitivity: Response, Coupling, and Cross-Scale Interaction (DOI: 10.5281/zenodo.18915677), and (3) Mediated Interaction in a Shared Dynamical Environment: A Mechanistic Extension of the Principle of Dynamical Sensitivity (DOI: 10.5281/zenodo.18968455). These three texts should be read together as a single structured progression developed in successive stages.

The trilogy should not be read as a claim of new physical laws, a new force, or a complete predictive theory. It should be read as a **philosophical-physical synthesis** that proposes a new interpretive perspective — one that draws on established dynamical tools and assigns them a unified conceptual role across physics, chemistry, and biology.

2. Known Tools, New Interpretive Perspective

The formal tools employed in the trilogy are not presented as original mathematical discoveries. The response function $\chi(\omega)$ and the realized response $R(\omega) = \chi(\omega)e(\omega)$ draw on the language of linear response theory as developed in the foundational work of Kubo [10]. The distinction between sub-threshold sensitivity and effective interaction has been explored in the context of stochastic resonance [11]. The emergence of organized structures through collective dynamical behavior and sequential coupling has been studied extensively in synergetics [7] and in the theory of dissipative structures [6]. The treatment of synchronization as a unified concept across physics, chemistry, and biology has been developed in the foundational work of Pikovsky, Rosenblum, and Kurths [12].

These contributions are well established within their respective domains. The present trilogy does not contest them. Rather, it proposes a new interpretive perspective: that these tools, when read together within a shared-environment framework grounded in the common dynamical origin of all structures, allow a unified conceptual language to emerge. This language differs

from the framework of Pikovsky et al. [12] in one specific respect: where that work develops synchronization as a dynamical phenomenon within nonlinear systems, the present trilogy situates the threshold within a broader cosmological and ontological framework — asking not only when synchronization occurs, but why structures sharing a common dynamical origin retain sensitivity even where synchronization does not. This distinction, and its grounding in a shared cosmological origin of all structures, is the interpretive contribution the trilogy proposes. The further development of this cosmological grounding — including its implications at cosmic scales and the question of harmonic inheritance across dynamical hierarchies — is identified as the subject of subsequent work.

3. What the Framework Proposes

The central proposal of the trilogy is the Principle of Dynamical Sensitivity: that structures emerging within a shared dynamical physical environment inherit sensitivity to its dynamical properties. This sensitivity is inferred from a physical observation rather than proposed as a metaphor. The dynamical environment in which all structures emerge traces back to the same primordial spectral background — oscillations, noise, and fluctuations originating at the earliest dynamical epochs, whose remnants remain measurable today in the form of CMB anisotropies and baryon acoustic oscillations [4, 5].

From this shared origin arises a developmental logic: primordial oscillations — chaining — coupling — synchronization — emergence of structures — oscillation of structures — chaining of structures, and so on, up to excitation, fluctuation, destabilization, and the reopening of dynamical bands for reorganization. Subsequent structures inherit frequency relationships — including, as a working hypothesis, harmonic modes both upward and downward — from the environment in which they formed, while also participating through feedback in the ongoing dynamics of that environment. The primordial spectral background and its measurable remnants — CMB anisotropies and baryon acoustic oscillations — are established physical observations [4, 5]. That structures emerging within this background inherit dynamical sensitivity in a cross-scale sense is the foundational working hypothesis of the trilogy. The mechanistic derivation of this connection is not attempted here and is identified as the central task of subsequent work.

Within this framework, a central conceptual distinction is introduced: the threshold is not a boundary of sensitivity, but a boundary of realized response. Structures may remain dynamically sensitive below the threshold — inheriting their predisposition from the shared dynamical background — while effective interaction emerges only when compatibility, coupling strength, and environmental conditions jointly exceed the threshold of realized response. This distinction is not incidental. It is the architectural core of the trilogy.

4. What the Framework Does Not Claim

The framework does not claim a new physical force, a universal communication channel across all scales, or a complete predictive theory. It does not claim that all structures interact with all others — inherited sensitivity remains latent unless the conditions for realized response are met. It does not claim that familiar response equations are original mathematical contributions. And it does not yet address information transfer or signaling as explicit components of the framework. These remain open questions for subsequent work.

A natural question follows: what does this framework explain that existing domain-specific descriptions do not? The present trilogy does not claim explanatory or predictive advantage

over established treatments of resonance, synchronization, or threshold behavior within their respective domains. Its contribution is of a different kind — conceptual unification across domains that currently treat these phenomena separately. One specific candidate for interpretive added value lies in the treatment of sub-threshold behavior: where standard descriptions do not typically assign structure to the region below threshold, the present framework proposes that it retains structure — in the form of latent inherited sensitivity. Whether this reinterpretation generates novel empirical predictions remains an open question and is identified as a priority for subsequent work. What the framework does claim is more modest and more precise. As an interpretive framework rather than a predictive theory, it does not generate falsifiable predictions in the strict sense. Its contribution lies in reading established dynamical tools together within a shared-environment perspective — grounded in the common dynamical origin of all structures — and in providing a coherent cross-disciplinary language for phenomena that are individually well documented but have not, to the author's knowledge, been previously addressed within a single interpretive structure of this kind.

5. How to Read Papers I–III as a Sequence

Paper I introduces the Principle of Dynamical Sensitivity and its physical and cosmological motivation. It establishes the conceptual basis: shared dynamical environment, inherited sensitivity, and the possibility of interaction across scales. Paper II operationalizes the principle through a response-based formal language, introducing the response function, the realized response, and the threshold criterion — explicitly drawing on established spectral tools while reinterpreting their role within the shared-environment framework. Paper III extends the framework mechanistically by showing how realized response may become mediated, chained, stabilized, weakened, or fail through emergent intermediate dynamical structures.

The trilogy should therefore be read as one structured progression rather than as three isolated claims — each paper deepening the same shared-environment hypothesis from a different analytical level. [1–9]

The trilogy is best read as a conceptual research program and not as a completed physical theory.

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This preface is intended as a standalone document and may be cited independently. The preprints of Papers I–III remain unchanged.