Systemic Continuum Paradigm and the Emergence of Fundamental Forces

Toward a New Systemic Physics

Ignacio Lucas de León Pontet (with contributions from augmented intelligence)
Preprint / Working Paper — February 25, 2025
Personal Email: nachofacultad@outlook.com

Abstract

This **third preprint** in the **Systemic Continuum Paradigm (PCS)** extends *Systemic Balance* theory into the domain of **fundamental physics**. Traditionally, physics treats forces like **gravity** and **dark energy** as universal and irreducible. By contrast, the **PCS** posits that these so-called "fundamental" forces **emerge** only when **Internal Systemic Balance (ISB)** surpasses a **Systemic Threshold (ST)**, yielding a **dominant force** that structures the **External Systemic Balance (ESB)** at a given scale. Once that scale saturates, a new threshold may be crossed, causing a *different* force to become the **dominant structuring agent**.

We develop:

1. **Gravity as an Emergent Force**: It does not appear at quantum scales (roughly below ~10^-35 m) because the system's **BS** is below the threshold needed for gravity to emerge.
2. **Dark Energy**: Interpreted as the next emergent property once gravity's domain saturates (~10 Mpc or larger), explaining cosmic acceleration **without** postulating new "exotic" substances.
3. **Law of Structuring Systemic Emergence (LSSE)**: Each scale has a *single, dominating force* that emerges upon crossing the ST, relegating other (non-dominant) emergent phenomena to subservient roles at that scale.
4. **No Forced Unification**: The PCS counters the usual push for a "Theory of Everything," seeing each force as valid in its emergent domain and avoiding paradoxes like "quantizing gravity."
5. **Implications for Cosmology**: The cosmic expansion, inflation, and Hubble constant discrepancies become predictable transitions within an evolving systemic continuum.
6. **Mathematical and Operational Tools**: We propose a more explicit mathematical approach and metrics (e.g., **Systemic Dominance Index**, **ICS** for synergy) to test emergent forces.

By embracing the **PCS** view, we shift from unifying all forces in a single set of equations to **modeling the emergent transitions** that define each force's domain. This approach fosters a "New Systemic Physics," challenging reductionism, encouraging interdisciplinary validation, and suggesting possible further transitions in the cosmos's future.

Table of Contents

---

1. Introduction

1.1. Background: From Systemic Balance to Fundamental Physics

In two preceding works—

- *Toward a Systemic Continuum: Dismantling the 'Natural vs. Artificial' Dichotomy as a New Paradigm in Systems Theory* (de León Pontet, 2025)
- *The Hierarchical Definition of Systemic Balance in the Systemic Continuum Paradigm: Toward a Unified Theory of Emergent Organization* (de León Pontet, 2025)

—the **PCS** was outlined as a **transdisciplinary** framework. **Systemic Balance (BS)** emerged as a hierarchical process (**ISB → ST → ESB**) that underlies the self-organization of any system—be it biological, social, or technological. Here, we **extend** that logic into **fundamental physics**, arguing that the so-called "fundamental" forces (gravity, electromagnetism, strong, weak, and dark energy) **emerge** at specific **systemic thresholds** and *dominate* only the scale at which they arise.

1.2. Goals of This Third Preprint

- **Redefine Gravity**: Show how PCS accounts for gravity's absence at quantum scales and its dominance at meso- to cosmic scales.
- **Elucidation of Dark Energy**: Present a threshold-based reason for cosmic acceleration.
- **Questioning Forced Unification**: Outline a new approach, the **Law of Structuring Systemic Emergence (LSSE)**, which bypasses paradoxes like "quantum gravity" by acknowledging each force's emergent scale.

---

2. Foundations: Recapping the Systemic Continuum Paradigm

2.1. PCS in Brief

The **PCS** holds that all "natural" and "artificial" systems are arranged along a continuum of self-organizing complexity, dissolving standard ontological divides (de León Pontet, 2025).

2.2. Systemic Balance and the Hierarchical Model (ISB → ST → ESB)

- **Internal Systemic Balance (ISB)**: Localized synergy among system components.

- **Systemic Threshold (ST)**: A synergy “critical zone.” Crossing it yields a qualitatively new property.
- **External Systemic Balance (ESB)**: The newly dominant property organizes the system at a higher scale.

2.3. The Observer as Catalyst

Crucially, PCS’s phenomenological stance sees the observer as **internal**. Emergent forces gain recognition through feedback loops that include observation, reminiscent of quantum measurement’s synergy with system states.

---

3. Law of Structuring Systemic Emergence (LSSE)

3.1. Statement of the Law

> **LSSE**: “At each scale’s systemic balance, exactly one force (or emergent property) becomes the **dominant** structuring agent after the internal interactions (ISB) exceed a critical threshold (ST), governing the External Systemic Balance (ESB) for that scale.” We designate this structuring emergent property as a ‘force’ within the PCS.

3.2. Why Only One Dominant Force Emerges per Scale

Once a particular force crosses the synergy threshold first, it reshapes the ESB in ways that exclude equally strong contenders. This mirrors how gravity outcompetes electromagnetism on cosmic scales, but not at atomic scales.

3.3. Non-Structuring Emergent Phenomena

Other properties or forces—electromagnetism, for instance—still exist but do not overshadow the newly dominant synergy at that scale.

---

4. Gravity as an Emergent Phenomenon

4.1. Traditional Efforts to Quantize Gravity

From string theory to loop quantum gravity, decades of research have failed to unify gravity with the quantum domain. The PSC suggests these attempts might be conceptually misplaced.

4.2. PCS Rationale: No Need for Quantum Gravity

Below the gravitational threshold (possibly near or below ~10^-35 m), **BS** is insufficient to “turn on” gravity. Hence, forced quantization is moot—gravity does not exist there to be quantized.

4.3. Transition Scale: Where Does Gravity Emerge?

PSC implies a synergy-based threshold. At sub-threshold scales, gravity is absent; beyond that threshold, it dominantly structures the ESB (e.g., planetary, stellar, galactic scales).

4.4. Comparisons to Alternative Models (e.g., Verlinde's Entropic Gravity)

While Verlinde posits gravity as an entropic effect, PSC sees synergy crossing an ST as the key driver. Entropy-based arguments may complement PSC's synergy viewpoint but do not address threshold-based dominance.

---

5. Dark Energy and the Next Threshold

5.1. When Gravity Saturates: Emergence of Dark Energy

Once matter extends beyond supercluster scales (~10 Mpc or more), gravity fails to fully organize the ESB. A new threshold is crossed, and **dark energy** emerges as the next dominant force.

5.2. Systemic Threshold at Cosmic Scales

This shift does not require postulating exotic fields; it's a natural progression of synergy once gravity "maxes out" and cosmic synergy transitions to a new property.

5.3. Cosmological Expansion as a Natural ESB Reconfiguration

Cosmic acceleration is thus a direct consequence of passing the ST at large cosmic scales. Each force is fully valid only within its synergy zone.

5.4. Possible Further Transitions (beyond Dark Energy)

If the universe expands indefinitely, PSC suggests yet another threshold could yield future emergent forces. Observed anomalies (e.g., Hubble tension) might be early hints of partial transitions.

---

6. Beyond the "Theory of Everything": PCS's Approach

6.1. Historical Pursuit of Unified Theories

Newton, Maxwell, Einstein, and modern quantum unifiers have all sought an ultimate single law.

6.2. PCS's Critique: Forces Aren't Fundamental

In PSC, each force emerges only in a certain synergy regime. We needn't unify them if they do not coexist dominantly at the same scale.

6.3. Advantages of a Multi-Threshold Model

- Eliminates paradoxes around "quantum gravity."

- Respects the success of each force in its own domain.
- Encourages looking for new emergent phenomena at uncharted scales.

---

7. Other Fundamental Forces

7.1. Electromagnetism, Strong, and Weak: Distinct Thresholds

Similarly, the strong interaction emerges as dominantly structuring hadrons, the weak interaction at subnuclear processes, while electromagnetism organizes molecular scales, overshadowed by gravity on large scales.

7.2. Predictive Frontiers: Undiscovered Forces at Hyper-Scales

PSC invites speculation that still-larger thresholds or energy domains might reveal new phenomena—a natural impetus for investigating cosmic “anomalies.”

---

8. Anomalies Suggesting Future Transitions

8.1. Hubble Constant Discrepancies

Conflicting measurements of the Hubble parameter might reflect partial synergy transitions or multi-threshold interplay.

8.2. Large-Scale Structure and Cosmic Web Patterns

Unusual patterns in galaxy distributions may indicate incomplete or nascent emergent forces.

8.3. Possible Inflation “Echoes” or Additional Thresholds

Early inflation might be recast as an initial emergent phenomenon. PSC would explore whether more threshold events followed.

---

9. Mathematical Formalization and Operative Metrics

9.1. Systemic Threshold Equations

ISB(t)=∑i,jwij xi(t) xj(t),ST={t∣ISB(t)>θ},ESB(t+1)=f(ISB(t), ST).\mathrm{ISB}(t) = \sum_{i,j} w_{ij}\, x_i(t)\, x_j(t), \quad \mathrm{ST} = \bigl\{ t \mid \mathrm{ISB}(t) > \theta \bigr\}, \quad \mathrm{ESB}(t+1) = f\bigl(\mathrm{ISB}(t),\, \mathrm{ST}\bigr).ISB(t)=i,j∑wijxi(t)xj(t),ST={t∣ISB(t)>θ},ESB(t+1)=f(ISB(t),ST).

9.2. Proposed Index for Emergent Gravity: “Gravitational Onset Function”

Let G(t) = 0 for ISB(t) < θg\theta_gθg and G(t) = 1 for ISB(t) ≥ θg\theta_gθg. This step function (or smoothed logistic curve) indicates when gravity emerges.

9.3. Revisiting ICS, CNS, MDO, and SDI for Fundamental Forces

- **ICS (Index of Co-Evolution Systemic)**: Overall synergy tracking.
- **CNS (Coefficient of Neutrality of the Substrate)**: Independence from underlying matter fields.
- **MDO (Metric of Dynamics of Observation)**: Observer's role in "locking in" emergent transitions.
- **SDI (Systemic Dominance Index)**: Quantifies a force's fraction of structuring power at a given scale.

9.4. Simulation Frameworks: Differential Equations and Network Models

Multi-scale agent-based or network simulations could show how transitions yield emergent "forces" once synergy surpasses θ\thetaθ.

---

10. Quantum Parallel: Why Gravity Is Not Found at Quantum Scales

10.1. PCS Explanation for Gravity's Non-Quantization

Since PSC states gravity emerges only above a synergy threshold, it is absent in low-scale quantum realms—there is nothing to quantize. The entire "quantum gravity" puzzle is thus sidestepped.

10.2. Observers and Measurement: A Bridge to Quantum Collapse?

PSC's embedded observer notion parallels quantum measurement theory, suggesting synergy thresholds might explain wavefunction "collapse" from a systemic perspective.

---

11. Observer Integration

11.1. Phenomenological Systemic Physics

By acknowledging the observer as an internal node, PSC merges phenomenology and physics, implying that emergent forces become recognized (and real) only via synergy that includes observational feedback.

11.2. Role of Conscious and Non-Conscious Observers in Forcing Transitions

While conscious observers can accelerate recognition or data collection, non-conscious processes can also catalyze synergy transitions (e.g., cosmic transitions happen independent of humans).

11.3. Epistemological Consequences

This approach subverts a purely external vantage, positing that cosmic “laws” reflect synergy + observation loops at the relevant scale.

---

12. Future Perspectives: Additional Forces and the Fate of the Cosmos

12.1. Potential for New Dominant Forces at Extremely Large or Late Times

Dark energy may not be the last word. If cosmic expansion continues, a new synergy threshold might spawn a further property that supersedes dark energy at ultra-late epochs.

12.2. Does the Universe Keep Crossing Thresholds Indefinitely?

PSC posits no final unification, but rather a chain of emergences. Each synergy system eventually saturates, giving way to the next.

12.3. Implications for Cosmic Destiny

From cyclical emergences to indefinite expansions, PSC fosters novel cosmic “endgame” scenarios. Testing them requires advanced observational data and synergy-based modeling.

---

13. Conclusion: Toward a Revolutionary Systemic Physics

13.1. Summary of Key Contributions

1. **Gravity** is emergent, absent in quantum realms, thus no need for forced quantization.
2. **Dark Energy** arises naturally after gravity saturates, explaining cosmic acceleration.
3. **Law of Structuring Systemic Emergence (LSSE)** ensures only one force dominates per scale.
4. **No “Theory of Everything”** is required: each emergent domain is valid in its synergy zone, removing contradictory unification attempts.

13.2. Formalizing the PCS Vision

Using synergy-based equations (ISB > θ\thetaθ → ESB) and new indices (SDI for dominance, MDO for observer impact), we can subject these claims to computational and observational scrutiny.

13.3. Invitation to the Scientific Community

We propose a **new systemic physics**, open to theoretical and experimental challenges. By abandoning forced unification, we see an evolving cosmos where each force reigns only at its scale. We welcome cross-domain collaboration—from particle physicists and cosmologists to complexity scholars—to explore, refine, or refute PSC’s predictions.

“By accepting forces as emergent transitions, we free ourselves from illusions of universal unification and embrace an evolving tapestry of thresholds, synergies, and catalytic observers shaping the destiny of the cosmos.”

References

- **de León Pontet, I. (2025).** *Toward a Systemic Continuum: Dismantling the ‘Natural vs. Artificial’ Dichotomy as a New Paradigm in Systems Theory.* PhilArchive.
- **de León Pontet, I. (2025).** *The Hierarchical Definition of Systemic Balance in the Systemic Continuum Paradigm: Toward a Unified Theory of Emergent Organization.* Preprint.
- **Verlinde, E. (2011).** On the Origin of Gravity and the Laws of Newton. *Journal of High Energy Physics.*
- **Riess, A. G., et al.** (2019). Large Magellanic Cloud Cepheid Standards Provide a 1% Foundation for the Determination of the Hubble Constant. *The Astrophysical Journal.*
- **Planck Collaboration.** (2018). Planck 2018 results. VI. Cosmological parameters. *Astronomy & Astrophysics.*
- **Kauffman, S. (1993).** *The Origins of Order: Self-Organization and Selection in Evolution.* Oxford University Press.
- **Wiener, N. (1948).** *Cybernetics: Or Control and Communication in the Animal and the Machine.* MIT Press.
- **Maturana, H., & Varela, F. (1980).** *Autopoiesis and Cognition: The Realization of the Living.* D. Reidel.
- **Clark, A., & Chalmers, D. (1998).** The Extended Mind. *Analysis*, 58(1).
- **Capra, F. (1996).** *The Web of Life.* Anchor Books.
- **Latour, B. (1993).** *We Have Never Been Modern.* Harvard University Press.
- **Haraway, D. (1985).** *A Cyborg Manifesto.* In Simians, Cyborgs, and Women. Routledge.
- **Kuhn, T. (1962).** *The Structure of Scientific Revolutions.* University of Chicago Press.
- **Merleau-Ponty, M. (1945).** *Phenomenology of Perception.* Gallimard.