Systemic Continuum Paradigm: Toward a New Systemic Physics of Emergent Forces

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Abstract

This **third preprint** in the **Systemic Continuum Paradigm (PCS)** extends **Systemic Balance (BS)** theory into the realm of **fundamental physics**. Traditionally, forces like **gravity** and **dark energy** are deemed universal and irreducible. By contrast, the **PCS** posits that these "fundamental" forces **emerge** only when **Internal Systemic Balance (ISB)** surpasses a **Systemic Threshold (ST)**, producing a **dominant force** that structures the **External Systemic Balance (ESB)** at a particular scale. Once that scale saturates, the system may cross a subsequent threshold, thereby introducing a *different* force to become the next **dominant** structuring agent.

We develop:

1. **Gravity as Emergent**: Absent below ~10^-35 m (quantum scales) because the system's BS is insufficient to "turn on" gravity.
2. **Dark Energy**: Appears after gravity saturates (~10 Mpc or larger), explaining cosmic acceleration without postulating exotic substances.
3. **Law of Structuring Systemic Emergence (LSSE)**: A single force per scale crosses its threshold first, relegating other phenomena to non-dominant roles.
4. **No Forced Unification**: PCS obviates paradoxes like "quantum gravity" by respecting each force's emergent domain.
5. **Cosmological Implications**: Inflation, cosmic expansion, and Hubble discrepancies emerge as synergy-driven transitions.
6. **Math & Operational Tools**: Provides a synergy-based approach (Systemic Dominance Index, ICS for synergy, etc.) to test emergent forces.

Building on the **second preprint** (introducing **General Systemic Balance, GSB**), we clarify that any **dominant** force "claims" the entire synergy domain at its scale, aligning fully with the **GSB** there. This synergy-based view reshapes fundamental physics into a **"New Systemic Physics,"** challenging reductionism, inviting interdisciplinary validation, and hinting at undiscovered cosmic transitions.

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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** (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*) guiding the self-organization of any system—biological, social, or technological. Here, we extend that logic into **fundamental physics**, positing that "fundamental" forces (gravity, electromagnetism, strong, weak, dark energy) **emerge** at specific **systemic thresholds** and **dominate** only at those scales.

1.2. Goals of This Third Preprint

- **Redefine Gravity**: Show how PCS resolves gravity's absence at quantum scales and dominance at larger ones.
- **Elucidation of Dark Energy**: Present an emergent synergy-based explanation for cosmic acceleration.
- **Questioning Forced Unification**: Introduce the Law of Structuring Systemic Emergence (LSSE), which acknowledges scale-bound forces without unifying them into a single theory.

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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)

The second preprint detailed **Systemic Balance (BS)**:

- **Internal Systemic Balance (ISB)**: Core interactions among system components.
- **Systemic Threshold (ST)**: The critical zone where synergy triggers new emergent properties.
- **External Systemic Balance (ESB)**: The restructured synergy dominating the new scale.

It also introduced **General Systemic Balance (GSB)**—the *comprehensive synergy at a given scale*. While multiple emergent properties may arise, only **one** typically aligns with the entire synergy domain (GSB), thereby becoming the scale's "force" or "structuring" property. Other emergent properties remain partial or non-dominant at that 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.

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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 internal synergy (ISB) crosses a threshold (ST). That property governs the External Systemic Balance (ESB), overshadowing non-structuring phenomena."

3.2. Why Only One Dominant Force Emerges per Scale

Once a property surpasses its threshold first, it "captures" the synergy domain. Other emergent properties do not scale to the entire synergy as long as the first dominates.

3.3. Non-Structuring Emergent Phenomena

Many emergent properties exist but do **not** overshadow the entire synergy domain at that scale; thus, they are overshadowed by the single structural property (the force).

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4. Gravity as an Emergent Phenomenon

4.1. Traditional Efforts to Quantize Gravity

For decades, physicists have tried unifying general relativity and quantum theory without success.

4.2. PCS Rationale: No Need for Quantum Gravity

Below ~10^-35 m, the synergy is too small for gravity to emerge. There's nothing to quantize if gravity does not exist at that scale.

4.3. Transition Scale: Where Does Gravity Emerge?

Once matter crosses a synergy threshold, gravity “turns on,” dominating meso- to cosmic scales.

4.4. Comparisons to Alternative Models

While Verlinde’s entropic gravity offers partial reinterpretations, PCS sees synergy thresholds as the central mechanism.

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5. Dark Energy and the Next Threshold

5.1. When Gravity Saturates: Emergence of Dark Energy

Beyond superclusters (~10 Mpc), gravity saturates, and dark energy emerges upon crossing a new threshold.

5.2. Systemic Threshold at Cosmic Scales

This shift requires **no** exotic field but reflects synergy exceeding gravity’s domain.

5.3. Cosmological Expansion as a Natural ESB

Cosmic acceleration follows from passing the threshold at very large scales.

5.4. Possible Further Transitions

If expansion continues indefinitely, another synergy threshold might reveal future emergent “forces.”

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6. Beyond the “Theory of Everything”: PCS’s Approach

6.1. Historical Pursuit of Unified Theories

From Newton’s universal laws to modern quantum unifiers, the goal has been a single “Equation of Everything.”

6.2. Claiming the General Systemic Balance

Each force “dominates” precisely when it **fully aligns** with the **General Systemic Balance (GSB)** at its scale. Gravity, for example, becomes the macroscopic GSB upon crossing its threshold first, overshadowing electromagnetism at that scale. This eliminates the impetus for forced unification: each force belongs to its synergy domain, coexisting across different thresholds without contradiction.

6.3. Advantages of a Multi-Threshold Model

No paradox of “quantizing gravity,” no single theory forced over all scales. Each domain has its synergy-bound property.

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7. Other Fundamental Forces

7.1. Electromagnetism, Strong, and Weak: Distinct Thresholds

Strong force structures subatomic realms, the weak handles nuclear transitions, while electromagnetism dominates molecular scales—none overshadow gravity in galaxies or dark energy in superclusters.

7.2. Predictive Frontiers

Untested synergy thresholds might exist at hyper-scales, giving rise to phenomena we have yet to observe.

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8. Anomalies Suggesting Future Transitions

8.1. Hubble Constant Discrepancies

Clashing measurements could reflect partial synergy shifts or multi-threshold interplay.

8.2. Large-Scale Structure and Cosmic Web Patterns

Unusual cosmic-web features may point to emergent forces not fully recognized.

8.3. Possible Inflation “Echoes”

Early inflation could be reinterpreted as a synergy threshold event.

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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} = \{t \mid \mathrm{ISB}(t) > \theta\}, \quad \mathrm{ESB}(t+1) = f(\mathrm{ISB}(t), \mathrm{ST}).ISB(t)=i,j∑wijxi(t)xj(t),ST={t∣ISB(t)>θ},ESB(t+1)=f(ISB(t),ST).

Preliminary, inviting further development.

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

G(t) = 0 for ISB(t) < θ_g and G(t) = 1 if ISB(t) ≥ θ_g. A logistic function could smooth this step.

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

- **ICS (Index of Co-Evolution Systemic)**: Overall synergy.
- **CNS (Coefficient of Neutrality of the Substrate)**: Whether properties transcend substrate dependence.
- **MDO (Metric of Dynamics of Observation)**: Observer's role in synergy.
- **SDI (Systemic Dominance Index)**: A force's fraction of scale-wide synergy.

9.4. Simulation Frameworks

Agent-based and network models at multi-scales can reveal emergent "forces" once synergy crosses thresholds.

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

10.1. PCS Explanation for Gravity's Non-Quantization

Below a certain threshold, gravity does not exist. The question of quantizing it is thus moot.

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

PSC's embedded-observer stance parallels quantum measurement theory, suggesting synergy thresholds help interpret wavefunction "collapse."

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11. Observer Integration

11.1. Phenomenological Systemic Physics

Acknowledging the observer as internal merges phenomenology with physics, asserting emergent forces only become "real" through synergy including observational loops.

11.2. Role of Conscious and Non-Conscious Observers

Conscious observers accelerate or reinterpret data; cosmic synergy transitions happen regardless of humans.

11.3. Epistemological Consequences

This approach subverts external vantage points, positing that cosmic laws reflect synergy + observation at each scale.

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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 might not be final—another synergy threshold may appear at ultra-large scales.

12.2. Does the Universe Keep Crossing Thresholds Indefinitely?

PSC posits no final unification. Each synergy eventually saturates, giving way to new emergences.

12.3. Implications for Cosmic Destiny

From cyclical emergences to indefinite expansions, PSC fosters novel cosmic endgame scenarios. Testing them demands synergy-based observational data.

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13. Conclusion: Toward a Revolutionary Systemic Physics

13.1. Summary of Key Contributions

1. **Gravity** is emergent—absent at quantum scales, no forced quantization required.
2. **Dark Energy** arises after gravity saturates, explaining cosmic acceleration.
3. **Law of Structuring Systemic Emergence (LSSE)**: Only one force dominates each scale.
4. **No "Theory of Everything"**: Each force is valid in its synergy zone, avoiding contradictory unification attempts.
5. **General Systemic Balance (GSB)** clarifies how that single force fully aligns with the scale-wide synergy.

13.2. Formalizing the PCS Vision

By synergy-based equations (ISB > θ → ESB) and new metrics (SDI for dominance, MDO for observational dynamics), we can test these claims. The GSB from the second preprint affirms how one property overlaps an entire scale's synergy domain.

13.3. Invitation to the Scientific Community

We propose a **new systemic physics**, built around emergent synergy thresholds rather than a single universal law. We welcome cross-domain collaborations—from quantum labs to large-scale cosmological teams—to investigate synergy transitions that define each force's realm, as well as future emergent forces yet unseen.

13.4. Bridging Physics and Systems Theory

A key aspiration of this preprint is to **integrate** physics squarely into **systems theory**, thereby expanding what was historically a bio-socio-techno framework to encompass **fundamental forces**. We suggest that **no** truly universal systems theory can omit the emergent nature of gravity, electromagnetism, dark

energy, and other forces. Rather than placing “forces” on an untouchable pedestal, we view them as **dominant emergent properties** coextensive with the **General Systemic Balance (GSB)** of each scale. This completes the systemist vision: *everything*—from city coralization to cosmic inflation—arises via synergy thresholds, forming a thoroughly **unified** perspective in which so-called “fundamental forces” are no more absolute than any other emergent property. They **win** or **dominate** only when their synergy surpasses a threshold, claiming the entire scale’s GSB.

> *“To unify all systems—biological, technological, social, and now physical—under one continuum is to recognize that all emergent organization, from neural networks to gravitational laws, is governed by the same synergy-based thresholds.”*

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