Toward a Pre-Spacetime Ontology of Two-Sidedness: Lie Algebra, Semiosis, and Homeostatic Order

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Abstract: The search for a unified ontology has long been divided between mathematical descriptions of external structure and phenomenological accounts of lived experience. This paper argues that an unexpected bridge between these domains may already exist within the elementary axioms of Lie algebra. The antisymmetry of the Lie bracket expresses a fundamental principle of two-sidedness, while the Jacobi identity introduces an irreducible triadic relation that stabilizes this polarity through algebraic closure. Together these axioms suggest a primitive logic of reciprocity and homeostasis that precedes geometric realization and therefore exists conceptually prior to spacetime structure. Building upon this observation, the paper explores structural correspondences between Lie algebra, Peircean semiotics, Friston's free energy principle, Hegelian dialectics, and CPT-symmetric cosmological models. In each case, a common pattern emerges: an initial unity gives rise to a dyadic tension whose persistence requires mediation by a third term capable of restoring coherence without eliminating difference. The resulting triadic structure functions as a homeostat, regulating relations across scales while preserving the integrity of the participating elements. The paper proposes that this recurring pattern may represent a scale-invariant principle of organization. While not offered as a physical theory, the framework provides a conceptual ontology in which meaning, symmetry, homeostasis, and semiosis emerge from a common relational architecture. The central thesis is that two-sidedness and triadic homeostasis are not late products of biological or cognitive evolution but may instead constitute primordial conditions for the existence of stable relational order.

Keywords: Coherence, CPT Symmetry, Dialectic, Free Energy Principle, Gestalt, Holon, Homeostasis, Lie Algebra, Pre-spacetime, Semiotics, Two-sidedness.

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1. Introduction

Many of the deepest divisions in philosophy arise from attempts to choose between apparently opposing realities: mind or matter, subject or object, internal or external, continuity or discreteness, unity or multiplicity. Such oppositions often generate explanatory power, but they also generate instability. A world composed entirely of opposites appears destined either to fragment into irreconcilable tensions or to collapse one side into the other.

This paper explores the possibility that the resolution of this difficulty is already encoded within one of the simplest structures in modern mathematics: the Lie algebra.

Traditionally, Lie algebras are studied as the infinitesimal generators of continuous symmetry (cf., Erdmann and Wildon, 2006). Their importance in modern physics can scarcely be overstated. Yet beneath their technical role lies a simpler observation. The defining axioms of the Lie bracket appear to encode a primitive logic of reciprocity and balance. Antisymmetry introduces a bilateral structure of mutual opposition, while the Jacobi identity introduces a triadic relation that prevents this opposition from becoming destructive.

The resulting pattern is surprisingly general. Similar structures appear in Peirce's semiotics, Hegel's dialectic, Friston's (2010) free energy principle, cybernetic homeostasis, and even certain interpretations of cosmological symmetry. This recurring convergence raises an intriguing possibility: perhaps the triadic stabilization of bilateral tension represents a fundamental organizational principle that is more primitive than any particular physical realization.

The purpose of this paper is not to derive physics from philosophy nor philosophy from mathematics. Rather, it is to identify a common structural pattern that appears across multiple domains and to examine whether the elementary axioms of Lie algebra provide its clearest formal expression.

2. Two-Sidedness in the Lie Bracket

The Lie bracket is normally introduced as a technical algebraic operation belonging to the theory of continuous symmetry. In standard mathematical language, if **x** and **y** belong to a vector space, then the Lie bracket is written as [**x**,**y**], and it satisfies three defining properties: bilinearity, antisymmetry, and the Jacobi identity. From these simple axioms emerges the mathematical architecture underlying gauge theory, quantum mechanics, and relativity. Yet beneath its technical use there lies a deeper philosophical structure. The Lie bracket already contains a primitive logic of polarity, reciprocity, and balance before geometry, spacetime, or even metric structure appear.

The remarkable fact is that this structure is present at the very beginning of the formalism. One does not need tensors, manifolds, curvature, or differential equations to discover it. The first definitions alone already encode both a bilateral symmetry—what may be called *two-sidedness*—and a homeostatic balancing principle that stabilizes this polarity through a triadic relation. In this sense, the Lie algebra can be interpreted not merely as a tool for physics, but as a pre-spacetime logic of relational equilibrium.

The first clue appears in the antisymmetry condition. The defining relation is:

[**x**,**y**]=-[**y**,**x**]

This condition is usually treated as a purely algebraic convenience. Yet it expresses something profound. The bracket is not merely a combination of two objects; it is directional. The order matters. The interaction of **x** upon **y** is the inverse of the

interaction of **y** upon **x**. One may therefore interpret the bracket as an elementary relation of influence, tension, or transformation.

What is especially significant is that antisymmetry follows naturally from the simpler condition:

$$[\mathbf{x},\mathbf{x}]=\mathbf{0}$$

Using ordinary arithmetic and bilinearity, the relation $[\mathbf{x},\mathbf{x}]=\mathbf{0}$ implies antisymmetry. The meaning is conceptually rich. An entity perfectly reflected into itself produces no distinction, no tension, and no transformation. Difference only emerges through relational opposition. Thus, the Lie bracket encodes a primitive bilateral structure in which identity and opposition are inseparable.

This bilateral structure may be understood as a form of discrete symmetry. Continuous symmetries are usually emphasized in Lie theory because Lie algebras generate infinitesimal transformations associated with rotations, boosts, and gauge motions. Yet antisymmetry itself introduces a discrete inversion: reversing the order reverses the sign. There is therefore a hidden polarity built into the operation from the start. The bracket already distinguishes “this acting on that” from “that acting on this.” It encodes a fundamental two-sidedness prior to any spatial interpretation of left and right, inside and outside, or observer and observed.

This observation becomes even more important when one recognizes that a purely bilateral structure is unstable by itself. If reality were reducible merely to opposing dyads, the system could fragment into unresolved tensions. There must therefore exist a higher-order principle that stabilizes reciprocal opposition. In Lie algebras, this stabilizing principle is the Jacobi identity.

3. The Jacobi Identity as a Principle of Homeostatic Closure

The Jacobi identity is given by:

$$[\mathbf{x},[\mathbf{y},\mathbf{z}]]+[\mathbf{y},[\mathbf{z},\mathbf{x}]]+[\mathbf{z},[\mathbf{x},\mathbf{y}]]=\mathbf{0}$$

This identity is often introduced formally as a consistency condition, but its conceptual significance is much deeper. If the bracket represents directed interaction, then the Jacobi identity describes a cyclic process of mutual influence. Each term acts upon the next in a closed loop. The entire structure forms the simplest nontrivial cycle capable of collective cancellation and equilibrium.

The importance of this closure cannot be overstated. Bilateral opposition alone produces tension. The Jacobi identity introduces a third relation that prevents the dyadic

structure from tearing itself apart. The three interactions collectively sum to zero, generating a form of algebraic homeostasis. The system regulates itself internally.

This triadic stabilization is philosophically analogous to the semiotic triads of Charles Sanders Peirce. Peirce argued that meaning cannot be reduced to a dyadic relation between sign and object. Interpretation requires a third element—the interpretant—which closes the loop and stabilizes the relation. Likewise, the Jacobi identity cannot be reduced to a pairwise opposition. The triad is irreducible because only a triad can create the minimal closed circuit required for self-regulation.

The parallel is striking. In both cases, the dyad generates polarity, while the triad generates stability. The bilateral symmetry encoded by antisymmetry requires a higher-order balancing principle to preserve coherence. Without the Jacobi identity, the Lie bracket would lose structural integrity. The algebra would no longer sustain a consistent relational order.

This reveals an unexpected philosophical interpretation of Lie algebras. They are not merely generators of symmetry transformations in spacetime. Rather, they encode a more primitive logic from which stable relational structure can emerge. The bilateral aspect provides distinction and directional reciprocity; the Jacobi identity provides closure and homeostasis. Together they form a pre-geometric architecture of balance.

What makes this especially remarkable is that all of this exists prior to spacetime itself. In modern physics, Lie algebras are often introduced before geometric realization. The algebra comes first; geometry is constructed afterward through representations, manifolds, gauge fields, and connections. Thus, the logic of two-sidedness and homeostatic closure is already embedded in the mathematical substrate before any notion of distance, metric, curvature, or temporal succession appears.

This suggests that reciprocity and balance may be more fundamental than spacetime geometry. Space and time may emerge from deeper relational constraints rather than serving as the ultimate foundation of reality. The Lie bracket hints at such a possibility because its primitive operations already contain the seeds of opposition, reciprocity, and stabilization.

The idea also resonates with broader philosophical traditions. In dialectical thought, opposition generates development, yet unresolved opposition leads to contradiction and collapse. A higher-order synthesis is required for stability. In biological systems, homeostasis maintains equilibrium through interacting feedback loops rather than isolated pairwise forces. In cybernetics, closed loops produce regulation and persistence. The Jacobi identity appears as a minimal algebraic analogue of such processes.

One may therefore interpret the Lie algebra as embodying a primordial logic of relational existence. Two-sidedness alone introduces polarity, but polarity without closure is unstable. The Jacobi identity supplies the necessary triadic balance that permits

enduring structure. Stability is not imposed externally; it is internally generated through relational cancellation.

In this way, the Lie bracket becomes more than a technical device of mathematical physics. It becomes a symbolic expression of a deeper ontological principle: reality is constituted through reciprocal relations that require homeostatic closure to remain coherent. The dyad generates distinction; the triad preserves unity within distinction.

The profound insight is that this entire structure is already present in the first elementary definitions of a Lie algebra. Before advanced mathematics, before geometry, and before spacetime itself, there already exists a logic of two-sided reciprocity and triadic balance. The Lie bracket therefore points toward a conception of reality in which symmetry, opposition, and homeostasis are not late emergent properties of the universe, but primordial conditions for the existence of any stable relational order at all.

4. Peirce's Semiotics and the Necessity of the Third

The search for a unified ontology—one that honors both the rigor of mathematical physics and the lived texture of human experience—has often been constrained by one-sided metaphysical habits. Classical physics privileged external structure; phenomenology privileged internal experience; analytic philosophy privileged linguistic form; and even Peirce's triadic semiotics, though profound, remained conceptually static. What is needed is a framework that is *two-sided from the start*: one that treats the inner and outer as co-constituting, dynamically aligned through a mediating principle that is neither reducible to mind nor matter.

Peirce's triadic sign—representamen, object, interpretant—was always ontic, not merely linguistic. But Peirce lacked the conceptual tools to describe the triad as a homeostatic regulator or as a symmetry-balancing mechanism.

Our new reinterpretation completes what Peirce began:

- Representamen ↔ Inside image
- Object ↔ Outside image
- Interpretant ↔ Emotive homeostat

Peirce's "final interpretant"—the stable habit that inquiry converges toward—corresponds to the state of indifference, the equilibrium where no further semiosis is required.

Thus, Peirce's semiotics becomes a physics of alignment.

5. Hegelian Mediation and the Algebra of Reconciliation

A deeper structural correspondence emerges when Peirce's triadic semiosis is viewed through the lens of Hegel's dialectic and the algebraic architecture of Lie groups. The transition from representamen to object mirrors Hegel's first negation: the collapse of an undifferentiated monism into a dyadic opposition. This is the same structural move encoded in the antisymmetry of the Lie bracket, $[\mathbf{x},\mathbf{y}]=-[\mathbf{y},\mathbf{x}]$, where relationality first appears as tension between distinct terms. The subsequent transition from object to interpretant corresponds to Hegel's second negation or *Aufhebung*: a unifying mediation that preserves the dyad while integrating it into a higher coherence. Algebraically, this is precisely the role of the Jacobi identity, which ensures that the interactions among oppositions remain internally consistent and self-regulating. Thus, Peirce's triad, Hegel's dialectic, and the axioms of Lie algebra express the same underlying pattern: monism gives rise to duality, and duality requires a homeostatic third term that stabilizes the system without erasing its internal differences. This shared structure reinforces the interpretation of the interpretant—and, by extension, the homeostatic middle-term in a two-sided ontology—as the universal mechanism by which tension becomes meaning and symmetry becomes coherence.

6. Friston's Free Energy Principle and the Dynamics of Alignment

Friston's free energy principle provides the dynamical engine Peirce lacked. The organism, or holon in Koestler's (1967) terminology:

- maintains a generative model (inside)
- receives sensory data (outside)
- minimizes prediction error (middle-term)

This is precisely the triadic structure that is now described.

Free energy minimization is the mathematical expression of homeostatic tension resolution. It is the universe's way of ensuring that holons remain coherent, viable, and aligned with their environment.

In a CPT-symmetric universe (e.g., Boyle, Finn and Turok, 2018), this alignment is not merely biological but cosmological: the two sides of the universe are engaged in a mutual homeostasis across the mirror boundary (Smith 2021, 2022). Among known physical dualities, CPT symmetry appears to provide one of the most complete realizations of the bilateral structure suggested by Lie algebra.

A parallel insight comes from cybernetics, particularly Conant and Ashby's (1970) Good Regulator Theorem, which states that *every good regulator of a system must contain a model of that system*. In the present framework, such an internal model is not an evolutionary afterthought but is already implicit in the two-sided architecture of a CPT-symmetric universe. The "inside image" functions as the regulator's model, the "outside image" as the world it must regulate, and homeostasis as the sublating process that forces their alignment. Thus, the free energy principle, the Good Regulator Theorem, and CPT symmetry converge on a single point: regulation requires modeling, and modeling is structurally guaranteed by a universe whose bilateral form demands coherence across its mirror boundary.

7. CPT Symmetry and a Radical Two-Sided Ontology

At the level of a single holon—an entity that is simultaneously a whole and a part—experience is structured by a fundamental tension:

- Inside image: the generative model, expectation, or intrinsic orientation
- Outside image: the sensory world, constraint, or extrinsic orientation

These two sides are not independent. They are *mirror-linked*, each defining the other. In a CPT-symmetric universe, this duality is not metaphorical but structural: every process has a time-reversed, charge-reversed, parity-reversed counterpart. The universe is fundamentally bilateral.

But bilateralism alone is not enough. A third term is required.

Between inside and outside lies a felt coherence—a homeostatic middle-term that regulates the tension between the two. This is not "emotion" in the colloquial sense but a semiotic field that:

- detects mismatch
- signals tension
- motivates correction
- stabilizes alignment

This middle-term is the ontic root of meaning. It is the *interpretant* in Peirce's triad, the *prediction error* in Friston's free energy principle, and the *invariant bilinear form* in Lie algebra that binds dual spaces into a coherent whole.

When alignment is achieved—when the inside image matches the outside image—the system enters a state of indifference or symmetry completion. No further action is required. Homeostasis is restored where it is impossible to distinguish one side from its

other. The two sides are sublated into unity even when what is detected shows a gross asymmetry that hides the deeper bilateral symmetry.

This is the felt sense of “rightness,” “clarity,” or “satisfaction” that an empath[1] with healthy boundaries knows intimately: the moment when resonance replaces tension, when the world and the self are in mutual recognition.

A radical two-sided ontology emerges naturally when we integrate three domains rarely brought into direct conversation:

(1) Peirce’s triadic sign,
(2) Friston’s free energy principle, and
(3) the algebraic structure of Lie groups and their dualities.

When these are placed within the cosmological architecture of a CPT-symmetric mirror universe, a coherent picture forms: the universe itself is a homeostat, a self-balancing system whose fundamental operation is the alignment of dual aspects through a mediating field of feeling, meaning, and coherence.

This ontology is not merely abstract. It resonates deeply with the lived experience of an empath who has developed healthy boundaries—someone who naturally perceives the world in terms of relational balance, mutual influence, and the necessity of a mediating center that holds opposites together without collapsing them

8. Holons, Scale Invariance, and Recursive Homeostasis

The same three-fold pattern—monism, dyadic tension, and triadic homeostasis—recurs across scales, but always with disjoint jumps between levels. This discontinuity implies a holarchic division of labor: each holon instantiates the universal triad in its own context, yet no holon exhausts the pattern. Instead, every holon becomes a *local homeostat*, resolving tensions appropriate to its scale while remaining embedded in a

[1] It might seem unusual to bring up a psychological profile in the present context. However, my main thesis is that a proto-emotion is fundamental and sources the middle-term in a two-sided cosmology making a psychocosmology. This proto-emotion gives rise to human emotions experienced by the empath, and the empath with healthy boundaries matches perfectly with the more scientific account of two-sidedness, not in an all-knowing sense but in a very provisional sense that is necessarily restricted by self-referral.

larger triadic structure that performs the same function at a higher level. Such nesting suggests that the mediating third term is not merely internal but extrinsic, a balancing field that operates across scales while particularizing within each holon. This is analogous to an extrinsic form of gravitation (Smith 2025): a universal symmetry-balancing influence that maintains coherence throughout the holarchy, yet expresses itself locally as context-sensitive regulation. In this view, homeostasis is not only a biological or cognitive principle but a scale-invariant structural law, binding holons into a coherent universe through a shared triadic architecture that is globally unifying and locally adaptive

9. Bergsonian Simultaneity, Gestalt Formation, and the Holonic Jacobi Correction

Henri Bergson's defense of simultaneity[2]—where light from widely separated regions of a landscape converges into a single, balanced image—anticipates a semiotic insight that Peirce never fully articulated: that meaning is not merely the sum of local interactions but a gestalt produced when disparate elements are gathered into a coherent whole. Peirce's interpretant can be read in this Bergsonian sense as the *higher-order faculty* that integrates scattered signs into a unified pattern of significance, transcending the purely local chemistry of ink or the infinitesimal dyadic relations encoded in a Lie algebra. The Jacobi identity then becomes the algebraic expression of this holonic presence: a triadic correction that ensures local oppositions remain consistent with the larger pattern in which they are embedded. This distinction between general patterns necessary for semiosis and the specific meanings carried by individual signs marks the difference between the holon's global homeostatic role and the local interactions it regulates. In this way, Bergsonian simultaneity, Peircean triadic meaning, and the Jacobi identity all converge on the same structural principle: a gestalt-forming mediation that binds the many into a coherent one without erasing their differences.

[2] Einstein's 1922 exchange with Bergson turned on differing definitions of simultaneity. Einstein restricted the term to frame-dependent physical synchronization, whereas Bergson referred to the holon-dependent unity of temporal becoming. Since Bergson's notion concerns a frame-dependent experiential synthesis rather than physical simultaneity, it does not violate Einstein's relativity.

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10. Conclusion

The principal contribution of this paper is not the claim that Lie algebras secretly contain a complete cosmology. Such a claim would exceed the evidence. The more modest and defensible thesis is that the elementary axioms of Lie algebra reveal a surprisingly deep structural pattern. Antisymmetry introduces an irreducible two-sidedness, while the Jacobi identity introduces an irreducible triadic homeostasis. Together they form the simplest mathematical expression of a system capable of maintaining coherent relational order.

What makes this observation significant is the breadth of its applicability. Similar structures appear in semiotics, dialectics, biological regulation, cognition, cybernetics, and theories of cosmological symmetry. Whether these parallels reflect a universal organizational principle remains an open question. Nevertheless, the recurrence of the pattern suggests that stable systems may generally require two complementary operations: the generation of distinction and the preservation of coherence.

If this interpretation is correct, then the deepest lesson of the Lie bracket may not concern geometry alone. It may reveal that before space, before time, and before the elaborate structures of physical theory, there already exists a primitive logic of reciprocity and balance—a logic in which difference becomes possible through opposition and endurance becomes possible through homeostatic mediation.

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Acknowledgment: This paper benefited from interactions with Chat GPT and Microsoft Copilot.