Restoring Bilateral Symmetry: Unifying Frieden's Extreme Physical Information with Friston's Free Energy Principle in a CPT-Symmetric Universe

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Abstract: This paper proposes a synthesis of Roy Frieden's Extreme Physical Information (EPI) framework and Karl Friston's Free Energy Principle (FEP) through the lens of bilateral symmetry and CPT invariance. While Frieden characterizes information flow as a one-way descent from intrinsic source information (J) to observed data information (I), this paper argues for a two-way, homeostatically balanced flow between J and I. This bilateral symmetry is not only epistemologically necessary but also metaphysically grounded in the CPT-symmetric structure of the universe. By integrating Friston's Markov blanket formalism and the minimization of variational free energy, we reinterpret Frieden's EPI as a special case of a broader, recursive homeostatic principle that governs both physical law and cognitive inference.

Keywords: Bilateral Symmetry, CPT symmetry, Extreme Physical Information, Free Energy Principle, Homeostat, Information, Markov blanket.

1. Introduction

Roy Frieden's EPI framework and Karl Friston's FEP represent two of the most ambitious attempts to ground physical and cognitive processes in information-theoretic principles. While Frieden's approach derives physical laws from the extremization of Fisher information, Friston's principle explains perception, action, and self-organization as the minimization of variational free energy. Despite their different domains, both frameworks hinge on the flow and transformation of information.

This paper proposes that these frameworks can be unified through the concept of bilateral symmetry—a two-way flow of information between source and observer, internal and external states—mediated by a homeostatic mechanism. This symmetry, we argue, is not merely a mathematical convenience but a reflection of the CPT-invariant structure of the universe.

To follow this paper some terminology and grounding speculations are needed. A homeostat is sensitive to a limited amount of sense information that relates to its purpose of maintaining balance. When bilateral symmetry is attributed to the activity of a homeostat it is relating a symmetry property to the implied sense information. According

to the Good Regulator Theorem,[1] good regulators or homeostats must act in a way that implies they carry an internal model of the world that they also regulate, and this pertains to the limited sense information that constitutes both the world and its model. When the homeostat has achieved balance, this information is found with perfect bilateral symmetry where the world and its model look identical and cannot be distinguished. Because everything looks the same from the homeostat's point of view when balance is achieved, there is no adjustment to be made. Adjustments are made only when asymmetry is detected that detracts from the idealized bilateral symmetry.

The activity of such homeostats that may complexify to maintain the overall balance of an organization, the holarchy in Arthur Koestler's terminology, presupposes a greater bilateral symmetry that is innate in the universe. Such a possibility is permitted by the CPT symmetric universe, and all the action principles of physics that are found CPT invariant. Keeping the two-sided universe in balance, by the activity of an extrinsic gravitation, has the effect of splitting off the gravitational drive into more limited expressions of homeostatic activities in the greater holarchy that are particularized for a single holon that has a provisional reach making a quantum gravity.

Note that a two-sided CPT symmetric universe that is held in balance by an extrinsic gravitation is a universe that has been sublated into unity. The two sides cannot be distinguished, and hence, the visible universe comes off as asymmetrical and far from showing bilateral symmetry. Thus, bilateral symmetry may be present in the grounding of reality, yet not visible to our eyes or detection. However, such a two-sided driver does generate strange attractions that lead to actual expressions of bilateral symmetry that are discovered in great abundance in nature.

2. Frieden's EPI: From J to I

Frieden's Extreme Physical Information (EPI) principle is built on the distinction between two types of Fisher information:

J: The intrinsic information of the source phenomenon.

I: The Fisher information extracted from data via measurement.

The EPI principle states that physical laws emerge from extremizing the difference between these two quantities, where in Frieden's notation: K = I - J = {extremum}.

This variational principle yields the equations of motion for various physical systems, from the Schrödinger equation to Maxwell's laws.[2] The flow of information is conceptualized as one-way: from the source (J) to the observer (I), with measurement acting as a coarse-graining process that inevitably loses information.

However, Frieden acknowledges that defining J requires prior knowledge—typically in the form of invariance principles or symmetry constraints.[3] This caveat implies that J is not purely given but must be inferred or constructed by attending to details, suggesting a top-down flow from I to J.

3. Friston's Free Energy Principle: From I to J

Friston's Free Energy Principle (FEP) offers a complementary perspective. It posits that biological and cognitive systems minimize variational free energy—a bound on surprise or prediction error—by adjusting internal models or acting to change the environment.[4] This process is mediated by the *Markov blanket*, which separates internal states from external causes via sensory and active states.[5]

In this framework:

Internal states (I) infer external causes (J) through perception.

Active states act on the environment to fulfill predictions.

The system thus engages in a continuous loop of inference and action, minimizing the discrepancy between its internal model and external reality. Not that Friston's approach is strictly limited to a one-way process, it can be understood as a *top-down* process: from internal expectations to external engagement.

4. Bilateral Symmetry and the Homeostat

The apparent asymmetry in Frieden's bottom-up flow (J → I) and Friston's top-down flow (I → J) can be resolved by positing a *bilateral symmetry*: a two-way flow of information mediated by a *homeostat*—a balancing mechanism that maintains equilibrium between source and observer, internal and external. In particular, the activity of a homeostat that minimizes surprise, in Friston's account, can be thought of as the

driver that restores bilateral symmetry, where the difference between the inside model and the outside world loses distinction and surprise is minimum when perfect bilateral symmetry is achieved.

In Frieden's account, the bilateral symmetry that achieves balance requires a more nuanced explanation. One simple argument is to assert that Frieden's construction of J is the activity of free energy minimization as Friston describes which is itself the drive of restoring bilateral symmetry by recovering the top-down mapping ($I \rightarrow J$). However, this is only a restatement of the speculation that the top-down mapping is implicit with CPT symmetry, but veiled by a two-sided cosmology that is sublated into unity where the pesty details of unification in the visibly asymmetric universe are ignored.[6] However, it is worthy of mention that Frieden's construction is based on attending to symmetry considerations which implies that some quantities are invariant, and invariant to the homeostat that is being described. These enter Frieden's formulation as constraints that are accommodated by adding terms to the Lagrangian which constitutes finding J. It would be too much to imply that the continuous symmetries considered by Frieden are induced by the discrete symmetry representing CPT invariance alone. However, it is only Friston's Markov blanket that is restricted to classically defined information representing probabilities, what rest beyond the blanket is extrinsic and what holds the two-sided cosmology together is a presumed extrinsic gravitation. It is not too much to presume that the symmetry considerations that Frieden uses to build J is the handiwork of something extrinsic and innate that works through CPT symmetry. Frieden is correct to approach empirical science as the act of discovering what is actually there, extrinsic or not. Likewise, the extrinsic driver permits the valid expression of all the humanities, including philosophy and the arts, independent of a scientism that ignores the possibility of an extrinsic driver. It is for this reason that Frieden's treatment of J comes off as open ended, and why the principle of two-sidedness does not lead to a theory of everything even while it achieves a provisional understanding.

An alternative synthesis of Friston's FEP and Frieden's EPI can be drawn from the additive nature of Fisher information. This additivity reflects the structure of the underlying probability space, such that the observed information P(I) is nested within the source information P(J). Metaphorically, this implies $I \subseteq J$, and thus $P(I \wedge J) = P(J)$: the act of observation does not extend beyond the generative source. The difference $J - I$ can then be interpreted as a kind of utility function—analogous to a log-ratio or information divergence—quantifying the discrepancy between what is generated and what is observed. Extremizing this difference, $J - I$, corresponds to maximizing the system's self-predictive capacity, a unifying principle that resonates with both Frieden's EPI and Friston's FEP, as well as a drive to restore bilateral symmetry in the mirror universe.

Therefore, it is reasonable to assert that a homeostat that is balanced by restoring bilateral symmetry is implicit in both frameworks assuming that the universe complies with CPT symmetry:

- In EPI, it is the variational principle that extremizes $I - J$.
- In FEP, it is the recursive minimization of free energy across the Markov blanket.

The homeostat ensures that neither J nor I dominate; instead, they co-evolve in a dynamic equilibrium. This restores a *bilateral symmetry* that mirrors the deeper symmetries of the universe.

5. CPT Symmetry and the Cosmic Homeostat

CPT symmetry—the invariance of physical laws under simultaneous reversal of charge (C), parity (P), and time (T)—is a cornerstone of modern physics.[7] Recent proposals suggest that the universe itself may be CPT-symmetric, with the post-Big Bang epoch being the mirror image of a pre-Big Bang anti-universe.[8]

In this context, the homeostat that balances J and I can be seen as a manifestation of CPT symmetry at the informational level. Just as CPT symmetry ensures the reversibility of physical laws, the bilateral flow between J and I ensures the reversibility of inference and observation.

This perspective aligns with Frieden's use of invariance principles to define J and with Friston's use of variational methods to update internal models. Both are governed by a deeper symmetry that transcends their specific domains.

6. The Markov Blanket as a Formal Homeostat

Friston's Markov blanket formalism provides a concrete instantiation of the homeostat. It defines the boundary between internal and external states and mediates their interaction through sensory and active states.[4]

The Markov blanket enables:

Perception: Internal states infer external causes via sensory input.

Action: Internal states act on external causes via active output.

This structure allows for *recursive self-organization* across scales, with nested Markov blankets forming a hierarchy of homeostatic systems.[5] Frieden's EPI, while not explicitly invoking the Markov blanket, can be interpreted as operating within such a structure, with J and I occupying opposite sides of an implicit boundary. Biological organization then forms naturally once the Markov blanket becomes explicit.

7. Multiscale Homeostasis and Emergent Complexity

The homeostat is not confined to a single scale. In both EPI and FEP, the same principles apply recursively:

- In EPI, different physical systems (quantum, classical, biological) are governed by the same variational principle.[3]

- In FEP, nested Markov blankets allow for the emergence of complex systems from simpler ones.[5]

This multiscale structure suggests that the bilateral symmetry between J and I is *scale-invariant*, operating from subatomic particles to cognitive agents. The homeostat thus becomes a *universal principle of organization*, akin to the principle of least action or maximum entropy.

8. Philosophical Implications

The restoration of bilateral symmetry has profound philosophical implications:

- It challenges the notion of unidirectional causality, replacing it with *reciprocal causation*.

- It dissolves the boundary between observer and observed, aligning with John Wheeler's "participatory universe."

- It elevates information from a passive descriptor to an *active principle of organization*.

By unifying Frieden's and Friston's frameworks, we move toward a *universal theory of inference and emergence*, grounded in symmetry, homeostasis, and information flow.

9. Conclusion

Frieden's EPI and Friston's FEP, though developed in different contexts, converge on a common principle: the dynamic balance between source and observer, internal and external, J and I. This balance is maintained by a homeostat that reflects the CPT-symmetric structure of the universe.

By restoring bilateral symmetry to Frieden's framework and interpreting the Markov blanket as a formal homeostat, we unify these two powerful theories under a single metaphysical umbrella. This synthesis not only deepens our understanding of physical law and cognitive inference but also points toward a more holistic, integrative science of reality.

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