



## Opinion

# The Cosmic Ledger: A Thermodynamic Mechanism for Gravity and the Hubble Tension

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**Abstract** - Dr. Melvin Vopson has proposed that gravity acts as a data compression mechanism within the framework of the Second Law of Infodynamics. We propose a speculative conceptual framework that augments this theory, suggesting that gravitational compression is a thermodynamic necessity dictated by the Law of Conservation of Energy. We introduce the Symbiotic Infodynamic Equilibrium (SIE) model, a qualitative hypothesis where the energy required for entropic State Realization ( $S_r$ ) is offset by the compression of spatial informational mass. While Vopson's original Second Law identifies information as a likely candidate for Dark Matter, it currently does not account for the accelerating expansion of the universe (Dark Energy). The SIE model attempts to address this by introducing an inverse relationship: in cosmic voids where information density is negligible, the conservation of energy necessitates spatial decompression. This mechanism offers a potential thermodynamic derivation for Dark Energy and a novel, density-dependent perspective on the Hubble Tension.

**Keywords** - Infodynamics; Data Compression; Gravity; Hubble Tension; Dark Energy; Mass-Energy-Information Equivalence.

## 1 Introduction: The Thermodynamic Mandate

Recent theories have proposed reshaping our understanding of the physical world through the Second Law of Infodynamics [1] and the postulation that gravity functions as a universal data compression mechanism [2]. These theories describe an elegant universe perpetually optimizing its own data. We propose a qualitative augmentation of these theories to account for this data compression not as an arbitrary choice, but as a necessary physical requirement dictated by the Law of Conservation of Energy. In an infodynamic universe where information has mass [3], the cost of creating new facts cannot be free. We propose the Symbiotic Infodynamic Equilibrium (SIE) model, where gravity acts to keep the universe's energy budget in balance. This hypothesis is qualitative and intended to motivate future modeling.

## 2 The Symbiosis of "In-form-ation"

The crux of this theory lies in the moment of State Realization ( $S_r$ ). To visualize this, consider the architecture of a mathematical proof. When a complex theorem is being derived, every

step must be explicitly calculated—a high-entropy state of maximum cognitive load. However, once the proof is established, it becomes a “given.” We do not re-derive the Pythagorean Theorem every time we design a bridge; we simply invoke it as a compressed unit of truth.

This transition from active derivation to established given is what we term State Realization. The final state is no longer a cloud of processing, but a realized idea “in form”—literally, “in-form-ation.” Per the Mass-Energy-Information (M-E-I) Equivalence Principle [3], this new “in-form-ation” possesses physical mass, and the production of that mass creates an energetic debt. To maintain a closed system where energy is conserved ( $dE_{total}/dt = 0$ ), the creation of this new informational mass must correspond to a reduction of mass-energy elsewhere.

This is the proposed causal mechanism behind gravitational compression: gravity is the universal offset [2]. As a state is realized, gravity pulls surrounding objects closer, reducing the number of “spatial address bits” required to define the system on the Planck-scale grid [4]. By “deleting” the informational overhead of spatial distance, gravity in turn generates the energy rebate needed to fund the new information.

### 3 Gravity as the Energetic Clearing House

Under this equilibrium, gravity is viewed not as an independent force of attraction, but as a physical byproduct of a universal process of deduplication. The debt is that each state realization adds bits ( $I$ ) to the system. The payment is that gravity reduces the bit-count of the spatial grid ( $\Delta I_{gravity}$ ).

$$\Delta I_{entropy} + \Delta I_{gravity} = 0 \quad (1)$$

This suggests why the Second Law of Infodynamics observes a decrease in information entropy [1]: the universe is running a perpetual process of compressing existing spatial data to afford the energy cost of creating new physical complexity.

### 4 Addressing the Hubble Tension

The SIE model offers a potential mechanism to address the Hubble Tension—the persistent discrepancy between the expansion rate measured locally and the rate predicted by the Cosmic Microwave Background [7].

If gravity is data compression caused by high information density, then Dark Energy is best understood as “data decompression” in regions of low information density. In the vast cosmic voids between galaxies—where State Realization is minimal—the system maintains energetic equilibrium by creating new spatial address bits (decompression).

Because the local universe is dominated by these voids compared to the uniform density of the early universe, the SIE model predicts that local measurements should inevitably show a faster expansion rate driven by this void decompression. Thus,  $H_0$  may not be a fixed constant, but an environmentally dependent variable determined by local information density.

### 5 Black Holes: Central Bank to the Universe

Black holes represent the extreme limit of this conservation cycle. We resolve the paradox of their high entropy [5] by distinguishing between active simulation data and archive data:

**The Singularity (Deleted Space):** This represents a total “pixel erasure” of spatial coordinates, providing the highest possible energy rebate to the system.

**The Event Horizon (Metadata Header):** The surface area ( $A$ ) is the minimum viable data required to keep the global ledger balanced without the massive energy cost of simulating the internal 3D volume [6].

In this sense, black holes function as the “Central Bank” of the universe, crushing mass into archives to provide the “liquidity” needed for complexity to bloom in the surrounding space.

## 6 Falsifiability and Experimental Validation

The SIE model moves beyond philosophical conjecture by offering specific, testable predictions that diverge from the Standard Model ( $\Lambda$ CDM).

Since this framework relies on the mass-energy-information equivalence, it is contingent on the experimental verification of information mass. Vopson has proposed observing the decay of Positronium to detect the conversion of information into energy (infrared photons) [1]. If these specific spectral lines are detected, it validates the thermodynamic “cost” of information that underpins the SIE model.

Additionally, the most immediate method to distinguish the SIE model from the Standard Model is through the observation of cosmic voids and the Hubble Tension. If future surveys confirm that local expansion rates are strictly correlated with the matter density of the line-of-sight (i.e., looking through voids yields higher  $H_0$ ), it would provide strong evidence for the SIE mechanism over a static Cosmological Constant.

## 7 Conclusion

Dr. Vopson established that the universe behaves with the efficiency of a self-optimizing system. The Symbiotic Infodynamic Equilibrium establishes the motive: the Law of Conservation of Energy. Gravity ensures that the cosmic books are always kept in balance, and that every realized bit of “in-form-ation” is paid for by the elegant compression of the space around it. A quantitative formulation of the SIE model remains future work.

## References

- [1] M. M. Vopson and S. Lepadatu, Second law of information dynamics, *AIP Advances*, vol. 12, no. 7, p. 075310, (2022)
- [2] M. M. Vopson, Is gravity evidence of a computational universe?, *IPI Letters*, vol. 3, no. 1, pp. N6-N9, (2025)
- [3] M. M. Vopson, The mass-energy-information equivalence principle, *AIP Advances*, vol. 9, no. 9, p. 095206, (2019)
- [4] M. M. Vopson, Estimation of the information contained in the visible matter of the universe, *AIP Advances*, vol. 11, no. 10, p. 105317, (2021)
- [5] J. D. Bekenstein, Black holes and entropy, *Physical Review D*, vol. 7, no. 8, pp. 2333-2346, (1973)
- [6] L. Susskind, The World as a Hologram, *Journal of Mathematical Physics*, vol. 36, no. 11, pp. 6377-6396, (1995)
- [7] A. G. Riess et al., A Comprehensive Measurement of the Local Value of the Hubble Constant, *The Astrophysical Journal Letters*, vol. 934, no. 1, p. L7, (2022)