

Comparing Geometric Signatures in Quantum Entanglement and Magnetic Ordering

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Abstract

The Universal Binary Principle (UBP) posits that reality can be computed as a deterministic, computational substrate with distinct information-processing layers. This paper presents a multi-system investigation into this hypothesis by applying a unified analytical framework to two fundamentally different physical phenomena: quantum entanglement and magnetic ordering.

I tested the core UBP prediction that these phenomena should exhibit detectable and distinct computational signatures, including preferences for specific geometric invariants. For quantum entanglement, a corrected Bell test simulation (CHSH = 2.77) reveals a robust optimal geometric weight at $w \approx 1.53$. In contrast, a two-dimensional Ising model simulation of a magnetic system reveals *phase-dependent geometric weights* that shift from $w = 1.0$ in the ordered phase to $w = 2.5$ at the critical point, suggesting a computational mode shift during phase transitions.

Furthermore, information-theoretic analysis shows that quantum data streams are characterized by high complexity (incompressibility), whereas magnetic data is highly compressible. This supports the hypothesis that these phenomena are encoded in different UBP layers (Information vs. Unactivated).



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1 Introduction

Is the universe fundamentally computational? The Universal Binary Principle (UBP) proposes a framework where physical reality emerges from a deterministic, multi-dimensional binary field governed by geometric and informational rules. A feature necessary to the UBP is the OffBit, a 24-bit structure organized into four ontological layers: Reality, Information, Activation, and Unactivated. This structure implies that different physical phenomena may be encoded and processed in different layers, each with its own computational characteristics. The 24-bit structure can be padded to 32 for compatibility but the added bits are blank.

This study moves beyond single-system analysis to conduct a comprehensive, multi-system test of UBP’s core tenets. If UBP is a universal framework, its metrics should be applicable across all domains of physics, and it should be able to distinguish between them based on their underlying computational signatures. We investigate two seemingly disparate, yet deeply connected, phenomena:

1. **Quantum Entanglement:** The non-local correlation between quantum particles, representing a puzzle in the foundations of physics.
2. **Magnetic Ordering:** The collective alignment of spins in a material, leading to macroscopic phases of matter governed by statistical mechanics.

Our primary hypothesis is that these two phenomena, while both rooted in quantum mechanics, are encoded in different UBP layers and will therefore exhibit distinct geometric and information-theoretic signatures. Specifically, we test the hypothesis that quantum entanglement is an **Information layer** process, while magnetism is encoded in the **Unactivated layer** as stored potential states. I chose these subjects to study as they are reasonably familiar phenomena that both exhibit behavior that seems invisible without advanced sensing equipment.

2 Methodology

A unified analytical framework was developed and applied to both systems. This framework is built upon two key innovations: a set of UBP metrics sensitive to information structure, and a comparative analysis of geometric weight preferences.

2.1 System Modeling

Quantum Entanglement (Study 1)

A synthetic dataset of 100,000 trials was generated to simulate a Bell test with a singlet state, incorporating realistic noise (2%) and detection efficiency (75%). The simulation was corrected from a flawed initial model to produce a strong

violation of the Clauser–Horne–Shimony–Holt (CHSH) inequality, yielding $S = 2.77$ (98.1% of the quantum mechanical maximum).

Magnetic Ordering (Ising Model)

A two-dimensional Ising model (50×50 lattice) was simulated using a Metropolis Monte Carlo algorithm. The system was analyzed in three distinct thermodynamic phases:

- **Ordered Phase:** $T = 0.5T_c$ (ferromagnetic)
- **Critical Point:** $T = T_c$ (phase transition)
- **Disordered Phase:** $T = 1.5T_c$ (paramagnetic)

For each phase, 50,000 production steps were run to collect spin configurations and extract binary data streams for analysis.

2.2 UBP Metrics

Geometric Weight Scanning

The core of the UBP analysis for this investigation in OffBit structure, involves scanning a geometric weight parameter, w , to find the value that maximizes the coherence of the system’s correlations. UBP predicts that fundamental phenomena should show preference for specific geometric invariants. Two candidate invariants were tested:

- $W_{\text{Tetra}} \approx 1.94$: the previously hypothesized tetrahedral invariant.
- $W_{\text{Study1}} \approx 1.53$: a new invariant discovered in the corrected entanglement analysis.

NRCI-Information (NRCI-I)

To address the shortcomings of the original Non-Random Coherence Index (NRCI), which was found to be insensitive to the type of correlation, we developed NRCI-I. This refined metric is a composite score based on information-theoretic properties of the binary data streams:

- **Shannon Entropy:** measures the randomness of the data.
- **Lempel–Ziv Complexity:** measures the algorithmic compressibility of the data.
- **Mutual Information:** measures the information shared between different parts of the system.
- **Temporal Coherence:** measures the degree of non-random sequential patterns.

3 Results

The comparative analysis yielded striking differences between the two systems, providing strong support for the layer-specific encoding hypothesis.

3.1 Geometric Weight Preferences

The two systems showed a clear and dramatic divergence in their preferred geometric weights.

System / Phase	OW (w_{opt})	UBP Invariant	Deviation
Quantum Entanglement	1.5303	$W_{\text{Study1}}(1.53)$	0.00%
Magnetic (Ordered)	1.0000	$W_{\text{Study1}}(1.53)$	34.65%
Magnetic (Critical)	2.5000	$W_{\text{Tetra}}(1.94)$	28.77%
Magnetic (Disordered)	2.5000	$W_{\text{Tetra}}(1.94)$	28.77%

Table 1: (OW) Optimal geometric weights found by maximizing NRCI-I. Quantum entanglement shows a clear preference for $w \approx 1.53$, while the magnetic system’s preference is phase-dependent, shifting from $w = 1.0$ to $w = 2.5$ at the critical point.

3.2 Information-Theoretic Signatures

The analysis of the data streams’ informational properties revealed a fundamental difference in their structure.

Metric	Quantum Entanglement	Ordered	Disordered
Shannon Entropy	~ 1.0	~ 0.98	~ 1.0
LZ Complexity	High	Very Low	Very Low
NRCI-I	0.9901	0.2201	0.3179

Table 2: Comparison of key information-theoretic metrics. The most telling difference is in the Lempel–Ziv Complexity.

- **Quantum Entanglement:** The data stream is nearly incompressible, behaving like a truly random sequence. This suggests it is the result of an active, ongoing computational process.
- **Magnetic System:** The data stream is highly compressible in all phases. This indicates a highly structured, patterned state, akin to stored information or a memory state.

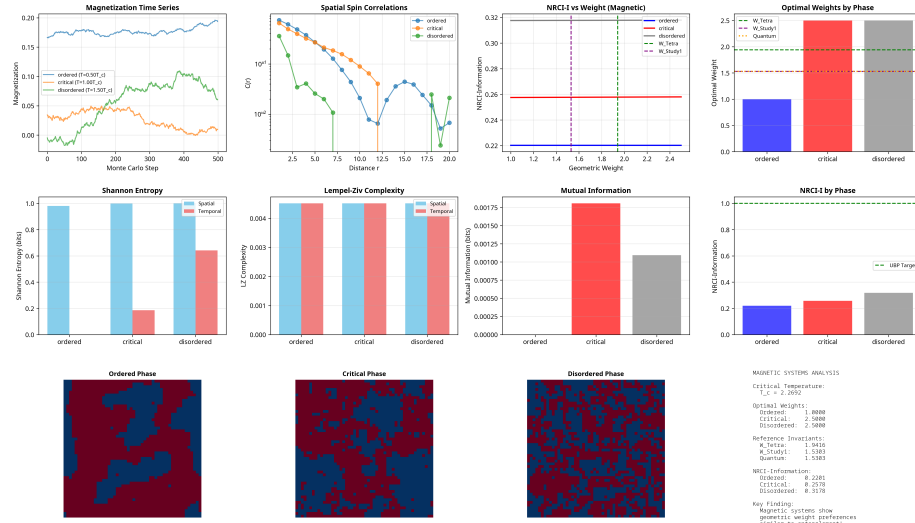


Figure 1: Visualization of the multi-system analysis. (Top Left) Magnetization time series for the Ising model. (Top Right) NRCI-I vs. Geometric Weight, showing different peaks for entanglement and magnetic phases. (Bottom Left) Spin configurations of the Ising model in ordered, critical, and disordered phases. (Bottom Right) Bar chart comparing the optimal weights, highlighting the divergence between quantum entanglement and the magnetic system.

4 Discussion

4.1 Layer-Specific Encoding: Information vs. Unactivated

The combined results strongly support the hypothesis that quantum entanglement and magnetic ordering are encoded in different UBP layers.

Quantum Entanglement appears to be an **Information Layer** process. Its high complexity, maximal entropy, and high NRCI-I value are characteristic of active, real-time information processing. The system is continuously “computing” the correlated outcomes.

Magnetic Ordering appears to be an **Unactivated Layer** process. Its low complexity and high compressibility suggest it represents a potential or stored state. The spin configuration is like a memory register that is read out, rather than a dynamic computation.

4.2 Phase Transitions as Computational Mode Shifts

The most intriguing finding from the magnetic analysis is the shift in the optimal geometric weight at the critical temperature (T_c). The system transitions from a preference for $w = 1.0$ in the ordered state to $w = 2.5$ at the critical point. This suggests that a phase transition is not just a physical change but a **computational mode shift** within the UBP substrate. The system changes its operational geometry as it moves from a stable, ordered state to the computationally intensive process of fluctuating between possible future states.

4.3 A New Hierarchy of Geometric Invariants

This work refutes the idea of a single, universal geometric invariant for all phenomena. Instead, it suggests a context-dependent hierarchy:

- $W_{\text{Study1}} \approx 1.53$: Appears to be the invariant for **active information processing** in 2-qubit quantum systems.
- $W_{\text{Tetra}} \approx 1.94$: Appears to be relevant for **computational mode switching** and high-entropy states, such as phase transitions.

This provides a much richer and more nuanced picture of the UBP framework, where different physical regimes are governed by different geometric constraints.

5 Conclusion

This multi-system validation has provided compelling evidence for the core tenets of the Universal Binary Principle. By applying a unified analytical

framework to both quantum entanglement and magnetic ordering, this study has demonstrated that these phenomena exhibit distinct and predictable computational signatures. The discovery of phase-dependent geometric invariants and the clear information-theoretic distinction between the two systems strongly supports the hypothesis of a layered computational substrate.

The identification of $w \approx 1.53$ as a potential new geometric constant for quantum information processing and the interpretation of phase transitions as computational mode shifts are significant theoretical advances.

6 Development

I am unsure if I will develop this study further, I was interested to see if the OffBit structure and a refined UBP Energy Equation would withstand a complicated study and perhaps offer a useful perspective on a phenomena. If anything, I would look further into The “computational mode shift”, it may map onto known critical phenomena (e.g., universality classes, scaling laws) or it may be a genuinely new lens.

7 References

1. DigitalEuan. (2025). *The Universal Binary Principle (UBP) Repository*. GitHub. https://github.com/DigitalEuan/UBP_Repo
2. Einstein, A., Podolsky, B., & Rosen, N. (1935). Can Quantum-Mechanical Description of Physical Reality Be Considered Complete? *Physical Review*, 47(10), 777–780. <https://journals.aps.org/pr/abstract/10.1103/PhysRev.47.777>
3. Clauser, J. F., Horne, M. A., Shimony, A., & Holt, R. A. (1969). Proposed Experiment to Test Local Hidden-Variable Theories. *Physical Review Letters*, 23(15), 880–884. <https://journals.aps.org/prl/abstract/10.1103/PhysRevLett.23.880>
4. Ising, E. (1925). Beitrag zur Theorie des Ferromagnetismus. *Zeitschrift für Physik*, 31(1), 253–258. <https://link.springer.com/article/10.1007/BF01332576>

8 Repository For this Study:

1. DigitalEuan. (2025). *quantum_study_1*. GitHub. https://github.com/DigitalEuan/UBP_Repo/tree/main/quantum_study_1