

Entanglement as the Universal Framework: Linking Gravity, Entropy, and Matter Through Photon Origin

Russell Crawford

Abstract

Quantum entanglement is typically regarded as a microscopic phenomenon, relevant to particles and quantum information. This paper extends entanglement to a universal framework, positioning it as the foundational structure underlying matter, gravity, and entropy. Beginning with zero-energy photon pairs that diverge into positive and negative components, entanglement is preserved as photons evolve into massive particles. The result is a cosmos in which all structures remain connected through a cohesive entangled field. Gravity is reframed as the macroscopic continuity of entanglement, binding systems across scales, while entropy emerges as the measure of entanglement's dispersal. By tracing matter, forces, and change back to photon entanglement at creation, this model presents entanglement as the fabric of reality itself.

1. Introduction

Entanglement has often been described as one of the most puzzling features of quantum mechanics — a linkage between particles that transcends distance. Einstein dismissed it as “spooky action at a distance,” while quantum theory treated it as a useful computational tool or experimental curiosity. Yet restricting entanglement to the microscopic domain fails to account for its deeper role. This paper advances the claim that entanglement is not peripheral but fundamental. Its origin lies in the first act of creation: the divergence of zero-energy photon pairs into positive and negative components. This divergence preserves balance while embedding correlation at the heart of existence. As photons evolve into particles, atoms, and larger systems, the entanglement seeded at origin persists. Within this framework, gravity and entropy are not separate laws but emergent expressions of entanglement. Gravity reflects continuity — the macroscopic preservation of linkage across scales. Entropy reflects dispersal — the diffusion of entanglement as complexity increases. Together, they demonstrate that the universe is not a collection of independent entities but a coherent entangled field. By tracing matter, gravity, and entropy back to photon entanglement, this model reframes entanglement as the universal grammar of reality — the principle that unifies structure and change.

This linkage is not purely spatial-it is structural, energetic, and informational. All mass in the universe carries with it a record of its entangled origin.

3. Entanglement as the Engine of Gravity and Entropy

This persistent entanglement offers a compelling framework for understanding gravity. Rather than arising solely from spacetime curvature, gravity may emerge from the underlying network of entangled mass. Every gravitational interaction would then reflect the quantum connectivity seeded by photon pair divergence.

Likewise, entropy-the measure of disorder or energy dispersal-is governed by the entangled potential between particles. Each entangled system carries within it the future of entropic unfolding. That is, entropy is not random, but coordinated across entangled nodes of matter.

This view leads to a radical insight: the laws of physics themselves may be the statistical expression of entangled conditions originating at the birth of matter. Because these laws emerge from the entangled network seeded by symmetric photon divergence, they are uniform and coherent across all regions of space. In this way, the consistency of physical laws is not a mystery of initial conditions, but a direct result of the underlying quantum entanglement that ties the universe together from its origin forward.

4. Conclusion: A Universe Entangled by Origin

In this framework, the entanglement seeded by photon pair divergence is not a footnote of quantum behavior-it is the architecture of the universe itself. Gravity and entropy emerge not as separate phenomena, but as coordinated outcomes of a deeply entangled system. Every particle of matter is not only a result of energy transformation, but also a node in a universal web that connects all physical reality.

5. Mathematical Implications and Entropic Gravity

The mathematical relationship between entanglement and entropy can be formally described using the von Neumann entropy formula:

$$S = -\text{Tr}(\rho \log \rho)$$

where ρ is the density matrix of a quantum system. In this framework, the entropy of entangled matter is not just a localized effect, but a reflection of the distributed informational state of the universe. Every entangled photon pair contributes to the global entropy profile.

This leads to an emergent view of gravity, as proposed in the entropic gravity framework by Verlinde, where gravitational force (F) arises from changes in entropy (S) over a spatial displacement (x):

$$F = T (dS/dx)$$

where T is the temperature associated with a holographic screen. If entangled photon pairs embed entropy at the foundational level of matter, then gravitational interaction may arise as a macroscopic expression of these entropic gradients.

Additionally, the ER = EPR conjecture suggests that spacetime itself may emerge from quantum entanglement. In this light, the structural consistency of the universe, including the uniformity of its physical laws, could be attributed to the underlying entangled framework seeded by photon divergence.

References

1. Crawford, R. (2025). Entangled Creation: Linking Photon Symmetry to the Evolution of Mass and Universal Structure. Figshare. <https://doi.org/10.6084/m9.figshare.29431346>
2. Crawford, R. (2025). Universal Compression and the Hidden Source of Gravity. Figshare. <https://doi.org/10.6084/m9.figshare.29553530>
3. Crawford, R. (2025). Exploring the Invariance of Photon Geodesic Paths: A Hypothesis on Photon-Graviton Interactions. Figshare. <https://doi.org/10.6084/m9.figshare.28736915>
4. Einstein, A., Podolsky, B., & Rosen, N. (1935). Can Quantum-Mechanical Description of Physical Reality Be Considered Complete? *Physical Review*, 47(10), 777-780.
5. Horodecki, R., et al. (2009). Quantum Entanglement. *Reviews of Modern Physics*, 81(2), 865-942.
6. Van Raamsdonk, M. (2010). Building up spacetime with quantum entanglement. *General Relativity and Gravitation*, 42(10), 2323-2329.
7. Verlinde, E. (2011). On the Origin of Gravity and the Laws of Newton. *Journal of High Energy Physics*, 2011(4), 29.
8. Maldacena, J., & Susskind, L. (2013). Cool horizons for entangled black holes. *Fortschritte der Physik*, 61(9), 781-811.

Methodology

This manuscript was prepared through an iterative process combining human reasoning and AI-assisted drafting. The author (Russell Crawford) defined the conceptual framework, original arguments, and final interpretations. ChatGPT (OpenAI, GPT-5 model) was used as a collaborative tool to assist in structuring the text, refining clarity, generating LaTeX formatting, and suggesting mathematical or linguistic formulations. All scientific content, interpretations, and conclusions are the responsibility of the author.