The Motion of Space: A Spiral Geometry for Unifying Constants and Predicting Physical Phenomena

Authors:

Lynn Lou Beran[1,*,†]
Zhu BenJiang[2,†]
Zhang XiangQian[2]

[1]Independent Researcher, United States
[2]Independent Researchers, China
*Corresponding author: lynn.l.beran@gmail.com
†Co-first authors

Date: July 10, 2025

Abstract:

We present a geometric framework that proposes fundamental physical constants may emerge from geometric relationships by modeling space as unfolding in a cylindrical spiral at constant rate. This approach yields dimensionless geometric ratios ($\hbar_0 = \pi$, $\alpha_0 = 1$, $G_0 = 1/\pi$) that, when appropriately scaled, may correspond to the Planck constant, fine structure constant, and gravitational constant, while suggesting how time, mass, energy, and charge might emerge as geometric properties of spatial motion.

Building upon the geometric insights of Einstein, Wheeler, and recent developments in teleparallel gravity, our coordinate-free formulation suggests a potential unification of quantum mechanics and general relativity through emergent spacetime dynamics. The spiral geometry suggests geometric origins for relativistic effects while proposing geometric origins for electromagnetic phenomena through torsional distortions and gravitational effects through radial curvature.

The framework generates six specific experimental predictions distinguishable from standard physics: electromagnetic resonance at rational periods ($T = 2\pi/n$), time-phase modulation of charge interactions, directional anisotropy in electric field coupling, periodic gravitational variations, vacuum interferometry phase shifts proportional to π, and spiral polarization patterns in plasma fields. These testable predictions provide potential empirical validation pathways for geometric approaches to fundamental unification, advancing Einstein's geometric program toward a complete physical theory derived from the motion of space itself.

Keywords: unified field theory, geometric physics, fundamental constants, mathematical physics, emergent spacetime, teleparallel gravity, spiral geometry, experimental predictions, quantum gravity, geometric algebra

PACS numbers: 04.20.Cv, 03.65.Ta, 03.50.De, 98.80.Qc

1. Theoretical Framework and Motivation

1.1 The Geometric Program in Physics

The quest to understand physical reality through geometric principles began with Einstein's revolutionary insight that gravity emerges from spacetime curvature. This "geometric program," built upon Minkowski's spacetime formulation, sought to replace physical forces with geometric properties of spacetime itself. Einstein's vision extended beyond general relativity toward a complete "unified field theory" that would geometrize all fundamental interactions.

Wheeler's geometrodynamics advanced this program with the insight that "spacetime tells matter how to move; matter tells spacetime how to curve," establishing spacetime as an active participant in physical processes rather than a passive arena. Contemporary developments have expanded this geometric tradition through multiple avenues:

Spacetime Algebra: Hestenes' geometric algebra provides "a unified, coordinate-free formulation for all of relativistic physics," demonstrating that geometric methods can unify classical, quantum, and relativistic phenomena while revealing hidden geometric structure.

Teleparallel Approaches: Modern teleparallel gravity describes gravitational effects through torsion in flat spacetime rather than curvature, showing that alternative geometric formulations can reproduce established physics while offering new insights.

Emergent Spacetime: Contemporary quantum gravity research increasingly treats spacetime as emergent from more fundamental structures, supporting the view that familiar spatial concepts may derive from deeper geometric principles.

1.2 The Fundamental Postulate

Patterns throughout nature—from galactic spirals to DNA helices to quantum orbital structures—exhibit spiral geometries. We propose this reflects a fundamental property of space itself, extending the geometric program through a specific dynamic structure:

Postulate: Space unfolds as a cylindrical spiral at a constant rate.

This approach builds directly on Wheeler's insight but proposes that space itself is in motion, creating the dynamic stage upon which all physical phenomena unfold. Rather than spacetime telling matter how to move, we propose that the motion of space generates both matter and the forces governing their interactions.

Recent work supports this direction: contemporary research demonstrates that electromagnetic phenomena can emerge from purely geometric considerations, interpreting "electric charge as a local compression of spacetime" and showing that "electric and magnetic fields are kinds of twists of spacetime." Our spiral emergence model provides a specific mechanism for such geometric generation of physical properties.

1.3 Methodological Context

Our geometric derivation follows established precedents in mathematical physics. Hestenes' spacetime algebra demonstrates that coordinate-free geometric methods can unify diverse physical phenomena, while teleparallel gravity shows that torsional geometric structures can reproduce gravitational effects. Recent studies of cylindrical spacetime geometries provide direct precedent for the geometric structures we employ.

The derivation of physical constants from geometric first principles, rather than empirical fitting, aligns with contemporary research suggesting that "universal constants emerge from geometric properties" and that "physical constants can be determined by geometric structures" rather than representing fundamental parameters.

1.4 Geometric Derivation of Spiral Components

Consider space emerging from a central origin with three fundamental modes of motion:

Radial emergence (z-direction): Space expands outward at each tick t. Without resistance, this would be $z(t) = t$ (pure linear expansion). However, the spiral nature creates periodic resistance as the emerging front encounters previous layers. This resistance follows $z(t) = t \cos(\pi t)$, where $\cos(\pi t)$ represents the interference pattern between current emergence and the existing spiral structure.

Tangential flow (y-direction): As space emerges radially, it simultaneously curves tangentially to maintain continuity. Each radial unit t corresponds to a half-revolution (π radians) of curvature, creating arc length $y(t) = \pi t$. This ensures the spiral maintains consistent geometric proportions.

Torsional deformation (x-direction): The spiral structure requires angular twist to prevent self-intersection as it grows. This torsional component follows $x(t) = t \sin(\pi t)$, where $\sin(\pi t)$ represents the orthogonal deformation needed to maintain the spiral's three-dimensional integrity.

The complete emergence path is:

$x(t) = t \sin(\pi t)$ [torsional component - charge]
$y(t) = \pi t$ [tangential component - space/energy]
$z(t) = t \cos(\pi t)$ [radial component - time/mass]

These directional assignments emerge from the geometric structure, though the relationship to physical coordinates requires empirical validation, consistent with coordinate-free formulations in geometric algebra. The x-axis governs torsional deformation (analogous to torsion-based descriptions of electromagnetic phenomena), the y-axis governs tangential flow (spatial/energetic emergence), and the z-axis governs radial expansion with resistance (temporal/massive manifestation). This geometric asymmetry provides the foundation for all subsequent physical distinctions.

This is not motion *through* space, but the motion *of* space itself—a dynamic geometric process generating the familiar structures of physical reality.

2. Immediate Consequences

2.1 Time as Radial Emergence

Time is the radial distance space has unfolded: $\mathbf{t = r}$

Each "tick" marks one unit of outward spiral growth. Time is not separate from space—it *is* the measure of spatial emergence.

2.2 Light Speed as Natural Ratio

As space emerges radially from $t = 0$ to $t = 1$, it simultaneously curves tangentially. The spiral completes exactly half a revolution (180°) per radial unit, tracing a semicircular arc of length:

Arc length = π × radius = π × 1 = π

Therefore, the natural speed of emergence is: **c_0 = arc length / radial distance = π/1 = π**

Light moves at this speed because it follows the intrinsic geometric flow of emerging space—pure tangential motion without radial resistance.

In geometric units, the natural emergence speed is $c_0 = \pi$. The relationship to physical units requires a conversion factor that scales the geometric framework to laboratory measurements. The physical light speed $c \approx 3\times10^8$ m/s emerges when geometric units are converted through appropriate scaling factors that relate the fundamental emergence tick to physical time intervals.

2.3 Mass as Geometric Resistance

When spiral emergence encounters resistance, the radial path curves: $z(t) = t \cos(\pi t)$

The cosine factor represents **mass**—geometric resistance to pure radial flow.

2.4 Charge as Torsional Twist

The x-component represents angular deformation: $x(t) = t \sin(\pi t)$

Electric charge is the magnitude of torsional twist in the spiral structure.

2.5 Action as Surface Area

As the spiral emerges radially along the z-axis, it simultaneously sweeps out a circular surface area in the x-y plane perpendicular to the radial direction. At each emergence tick t, the spiral has traced a tangential arc length of πt while maintaining a radial distance of t from the origin.

The circular surface area swept in the x-y plane is: $\mathbf{A = \pi t^2}$

This surface area represents the geometric "footprint" of spatial emergence at each moment. The area grows quadratically with emergence time, reflecting the expanding influence of the spiral structure.

At the fundamental tick $t = 1$: $A = \pi$, defining the quantum of action (Planck's constant). This establishes a direct geometric connection between the spiral's surface area and the fundamental quantum of physical action.

3. Geometric Relationships Corresponding to Physical Constants

3.1 Geometric Foundations

Following the tradition of deriving physical relationships from geometric first principles, we show that dimensionless ratios analogous to fundamental constants emerge naturally from spiral geometry. This approach extends recent work suggesting that "electromagnetic phenomena can emerge from purely geometric considerations" and builds upon geometric interpretations where "physical constants can be determined by geometric structures."

At the fundamental emergence tick $t = 1$, the spiral geometry yields dimensionless geometric ratios without free parameters within the geometric framework. These ratios, when combined with appropriate unit conversion factors, correspond to physical constants.

3.2 Planck Relationship

$\boldsymbol{\hbar_0 = \pi}$ *Surface area swept per emergence tick*

In geometric units, the quantum of action corresponds to the surface area swept by the spiral at the fundamental tick. The relationship to the physical Planck constant $\hbar$ requires scaling factors that relate geometric time and energy units to laboratory measurements.

3.3 Fine Structure Relationship

At $t = 1$, the emergence rates reveal a fundamental asymmetry:

- Torsional: $dx/dt = \sin(\pi) + \pi \cos(\pi) = 0 + \pi(-1) = -\pi$
- Tangential: $dy/dt = \pi$

This directional opposition parallels recent geometric interpretations where electromagnetic effects arise from "twists of spacetime" and provides a geometric foundation for electromagnetic coupling.

The dimensionless ratio of their magnitudes: $\boldsymbol{\alpha_0 = |dx/dt| / |dy/dt| = \pi / \pi = 1}$ *Equal but oppositely-directed coupling between electromagnetic and spatial emergence*

This geometric ratio $\alpha_0 = 1$ suggests perfect coupling in natural spiral units. The correspondence to the physical fine structure constant $\alpha \approx 1/137$ likely involves unit conversion factors between geometric and electromagnetic scales.

3.4 Gravitational Relationship

The radial emergence at $t = 1$ gives $z(1) = \cos(\pi) = -1$, suggesting gravity's geometric nature. This negative value indicates that mass creates resistance opposing pure outward emergence, causing the spiral to bend inward—a geometric interpretation of gravity's universal attraction.

The surface area swept at $t = 1$ is $A = \pi$.

The gravitational coupling ratio: $\boldsymbol{G_0 = |z(1)| / A = 1 / \pi}$ *Unit inward resistance distributed over the emergence surface*

3.5 Elementary Charge Relationship

The fundamental unit of charge corresponds to one complete torsional cycle in the spiral: $\boldsymbol{e_0 = 1}$ *One complete torsional twist*

This represents the minimal discrete unit of angular deformation within the spiral structure.

3.6 Coulomb Relationship

Electric interaction occurs when two elementary charges ($e_0 = 1$) couple across the spiral emergence surface.

The charges are naturally separated by the spiral's arc length π, and they interact across the circular surface area $A = \pi$.

The electromagnetic coupling ratio: $\boldsymbol{k\_e_0 = (e_0)^2 / A^2 = 1^2 / \pi^2 = 1/\pi^2}$

3.7 Relationship to Physical Constants

The geometric ratios derived here—such as $\hbar_0 = \pi$, $\alpha_0 = 1$, and $G_0 = 1/\pi$—represent intrinsic relationships within the natural units of spiral emergence. These dimensionless or geometrically scaled quantities require appropriate unit conversion factors to relate to laboratory measurements.

Physical constants with dimensions arise when spiral quantities are expressed in SI units through scaling relationships such as:

- Planck constant: $\hbar = \hbar_0 \times$ (conversion factors for energy×time)
- Gravitational constant: $G = G_0 \times$ (conversion factors for space-time curvature)
- Fine-structure constant: $\alpha = \alpha_0 \times$ (conversion factors for electromagnetic coupling)

The precise values of these conversion factors depend on how the fundamental spiral tick maps to physical scales. While our geometric framework suggests these relationships should exist, determining the exact scaling requires either empirical measurement or additional geometric principles beyond the current scope.

These geometric ratios emerge as inevitable consequences of spiral geometry rather than fitted parameters—suggesting that the geometric program may provide a foundation for understanding why physical constants have their observed values.

4. Physical Phenomena from Spiral Mathematics

4.1 Geometric Foundation for Physical Laws

The spiral geometry naturally reproduces established physical laws while revealing their geometric origins. This follows the pattern established by geometric algebra, which shows that "geometric methods can unify classical, quantum, and relativistic physics while elucidating geometric structure."

4.2 Relativistic Effects

From the spiral geometry $(x, y, z) = (t \sin(\pi t), \pi t, t \cos(\pi t))$:

4.2.1 Time Dilation Derivation:

The spiral geometry naturally reproduces the Lorentz transformation discovered in the context of electromagnetic theory. Consider an observer moving with tangential velocity v along the y-direction of the spiral.

For a stationary observer, the spiral components are:

- $x(t) = t \sin(\pi t)$
- $y(t) = \pi t$
- $z(t) = t \cos(\pi t)$

The key insight is that light follows the pure tangential direction (y-component) at the natural emergence speed $c_0 = \pi$. For any observer, the speed of light must remain constant at π in their reference frame.

Consider an observer moving with velocity v in the tangential direction. In this observer's frame, light must still propagate at speed π. However, the observer's motion relative to the spiral structure creates a geometric constraint.

From the observer's perspective, the effective tangential distance covered by light is $(\pi - v)$ per unit emergence time, while the total distance must still equal π. This requires a time dilation to maintain the light speed invariance.

If dt' is the proper time interval for the moving observer and dt is the coordinate emergence time, then:

Distance covered by light in moving frame = $\pi \times dt'$
Distance covered by light in stationary frame = $\pi \times dt$

The geometric constraint that light maintains speed π in both frames, combined with the relative motion v, yields:

From the spiral geometry, light's path forms a right triangle where the hypotenuse represents the total distance πdt in the stationary frame, one leg represents the observer's displacement vdt, and the other leg represents the effective light distance πdt' in the moving frame.

$\pi \times dt' = \sqrt{[(\pi \times dt)^2 - (v \times dt)^2]}$

Simplifying: $\pi \times dt' = dt \times \sqrt{[\pi^2 - v^2]}$

Therefore: $dt' = dt \times \sqrt{[\pi^2 - v^2]}/\pi = dt \times \sqrt{[1 - v^2/\pi^2]}$

The time dilation factor is: $\boldsymbol{\gamma = dt/dt' = 1/\sqrt{(1 - v^2/\pi^2)}}$

This derivation shows how the invariance of the light speed π in the spiral geometry naturally leads to relativistic time dilation, with π playing the role of the limiting speed in our geometric units.

4.2.2 Length Contraction:

Consider a rod of proper length L_0 oriented in the tangential direction (y-axis) and at rest in the spiral frame. When observed from a frame moving with velocity v, the rod appears contracted.

In the moving frame, the rod's endpoints are measured simultaneously at time t'. However, due to the relativity of simultaneity in the spiral geometry, events that are simultaneous in the moving frame occur at different emergence times in the stationary frame.

For the moving observer, the effective tangential distance is modified by the same geometric factor that produces time dilation. Since the spiral maintains its geometric integrity, the tangential coordinate contracts as:

$L = L_0/\gamma = L_0\sqrt{(1 - v^2/\pi^2)}$

This contraction preserves the geometric relationships within the spiral structure while accounting for the relative motion between reference frames.

4.2.3 Mass Increase:

In the spiral emergence framework, mass represents geometric resistance to radial flow: $m_0 \propto |\cos(\pi t)|$. For a moving particle, the enhanced resistance arises from the coupling between the particle's motion and the spiral's geometric structure.

A particle moving with velocity v experiences increased geometric resistance because its motion creates additional disturbance in the spiral emergence pattern. The resistance factor becomes:

$|\cos(\pi t)| \rightarrow \gamma|\cos(\pi t)|$

This enhanced resistance manifests as increased inertial mass:

$m = \gamma m_0 = m_0/\sqrt{(1 - v^2/\pi^2)}$

The geometric origin of this mass increase reflects how motion through the spiral structure amplifies the underlying resistance to spatial emergence, providing a geometric foundation for the equivalence of inertial and relativistic mass.

4.3 Electromagnetic Phenomena

The electromagnetic field emerges from torsional distortions in the spiral structure, consistent with recent work showing that "electric and magnetic fields are kinds of twists of spacetime." The following detailed derivations show how electric and magnetic fields arise directly from the spiral geometry.

4.3.1 Electric Field Derivation

In the spiral geometry framework, the torsional component of emergence is defined as:

$$\mathbf{x(t) = t \cdot \sin(\pi t)}$$

This expression represents the angular deformation of space in the x-direction. In this model, the electric potential is defined geometrically by the torsional twist:

$$\boldsymbol{\varphi(t) = x(t)}$$

Following classical electrodynamics, the electric field is the negative gradient of the scalar potential:

$$\mathbf{E = -\nabla\varphi}$$

Since the system is parameterized by emergence time **t**, and space is unfolding from it, the gradient operator reduces to time derivatives. Therefore, the electric field strength is proportional to the second derivative of torsional deformation:

$$E(t) \propto d^2x/dt^2$$

We compute this step by step:

First derivative: $dx/dt = d/dt\,[t \cdot \sin(\pi t)] = \sin(\pi t) + \pi t \cdot \cos(\pi t)$

Second derivative: $d^2x/dt^2 = d/dt\,[\sin(\pi t) + \pi t \cdot \cos(\pi t)] = \pi \cdot \cos(\pi t) + \pi \cdot \cos(\pi t) - \pi^2 t \cdot \sin(\pi t) = 2\pi \cdot \cos(\pi t) - \pi^2 t \cdot \sin(\pi t)$

Final expression for electric field strength: $E(t) \propto 2\pi \cdot \cos(\pi t) - \pi^2 t \cdot \sin(\pi t)$

Interpretation

- The term $2\pi \cdot \cos(\pi t)$ reflects the natural oscillation of torsional emergence.
- The term $-\pi^2 t \cdot \sin(\pi t)$ shows increasing field strength due to accumulated twist over time.
- The electric field emerges entirely from the spiral's intrinsic geometry—Electric fields emerge without assuming charge as a fundamental substance—only from the geometry of spiral motion.

This derivation demonstrates that electric field behavior arises directly from the second-order dynamics of torsional emergence in spiral space.

4.3.2 Magnetic Field Derivation

In the spiral geometry model, the magnetic field arises from the circulation of torsional flow. This flow is defined by the time derivative of the torsional component:

$$x(t) = t \cdot \sin(\pi t)$$

The torsional velocity is given by:

$$v_x(t) = dx/dt = \sin(\pi t) + \pi t \cdot \cos(\pi t)$$

This represents the rate of angular deformation along the x-axis. The magnetic field is defined geometrically as the curl of this torsional velocity:

$$B = \nabla \times v_x(t) = \nabla \times [dx/dt]$$

In this formulation, spatial coordinates are not yet fully developed; the magnetic field is represented symbolically via the time-domain torsional flow. A full spatial vector-field treatment will be developed in future work

In this one-dimensional time-parameterized model, the curl becomes a symbolic representation of circulation. Since spatial coordinates are not explicitly used, we interpret the curl as capturing how the velocity field circulates around closed loops perpendicular to the direction of flow.

Summary Expression: $\mathbf{B(t) \propto \nabla \times [\sin(\pi t) + \pi t \cdot \cos(\pi t)]}$

Although a full spatial vector field is not specified in this simplified model, the torsional flow implies a loop-like circulation. Thus, we treat B(t) as a pseudo-vector whose magnitude reflects the strength of this induced circulation.

Interpretation

- The term $\sin(\pi t)$ represents the oscillatory twist of the spiral structure.
- The term $\pi t \cdot \cos(\pi t)$ introduces time-dependent buildup of torsional momentum.
- The magnetic field emerges as a consequence of the rotational inertia of space as it twists through time.

Together, these components describe how magnetic effects originate from the evolving spiral geometry—specifically, from how the rate of torsional change rotates or curls across the emerging space.

This derivation shows that the magnetic field, like the electric field, is not a separate entity but an emergent feature of the geometric motion of space, governed by the torsional structure of the spiral.

4.3.3 Light Propagation

In the spiral emergence model, **light** corresponds to pure motion along the **tangential direction** of the spiral. The tangential component of space emergence is given by:

$$\mathbf{y(t) = \pi t}$$

This motion is linear and unimpeded, with a constant rate of emergence:

$$\mathbf{dy/dt = \pi}$$

This defines the **natural emergence speed:**

$$\mathbf{c_0 = \pi}$$

Light propagates exclusively along this direction, without torsional (x) or radial (z) resistance. Since this direction represents **pure spatial unfolding**, light moves at the maximum possible speed, which is a fundamental geometric limit in this framework.

4.3.4 Electromagnetic Waves

Electromagnetic radiation arises from **coupled oscillations** of the electric and magnetic fields—both rooted in the torsional geometry. To understand wave propagation, we examine the time evolution of both field components.

Electric Field Time Evolution:

From our earlier derivation, the electric field is: $\mathbf{E(t) \propto d^2x/dt^2 = 2\pi \cdot cos(\pi t) - \pi^2 t \cdot sin(\pi t)}$

The time rate of change of the electric field is: $\mathbf{\partial E/\partial t \propto d^3x/dt^3}$

Now compute the third derivative:

$$d^3x/dt^3 = d/dt\,[2\pi \cdot \cos(\pi t) - \pi^2 t \cdot \sin(\pi t)]$$

Differentiate each term:

First term:

$$d/dt\,[2\pi \cdot \cos(\pi t)] = -2\pi^2 \cdot \sin(\pi t)$$

Second term (using product rule):

$$\begin{aligned} &d/dt\,[-\pi^2 t \cdot \sin(\pi t)] \\ &\quad = -\pi^2 \cdot \sin(\pi t) - \pi^3 t \cdot \cos(\pi t) \end{aligned}$$

Combine both results:

$$\begin{aligned} d^3x/dt^3 &= -2\pi^2 \cdot \sin(\pi t) - \pi^2 \cdot \sin(\pi t) - \pi^3 t \cdot \cos(\pi t) \\ &= -3\pi^2 \cdot \sin(\pi t) - \pi^3 t \cdot \cos(\pi t) \end{aligned}$$

Magnetic Field Time Evolution

From earlier, the magnetic field is defined by the circulation of torsional velocity:

$$\begin{aligned} B(t) &\propto \nabla \times [dx/dt] \\ &= \nabla \times [\sin(\pi t) + \pi t \cdot \cos(\pi t)] \end{aligned}$$

The time rate of change of the magnetic field is:

$$\begin{aligned} \partial B/\partial t &\propto \nabla \times [d^2x/dt^2] \\ &= \nabla \times [2\pi \cdot \cos(\pi t) - \pi^2 t \cdot \sin(\pi t)] \end{aligned}$$

This shows that the evolution of the magnetic field is governed by the changing curvature of the torsional flow in time.

Wave Coupling Mechanism:

The coupling between electric and magnetic oscillations creates self-sustaining electromagnetic waves. The changing electric field $\partial E/\partial t$ generates magnetic field circulation, while the changing magnetic field $\partial B/\partial t$ generates electric field circulation, forming a **self-propagating spiral disturbance**.

This disturbance travels tangentially at the natural emergence speed $\mathbf{c_0 = \pi}$, combining:

- **Torsional twist oscillations** (electric component)
- **Torsional circulation oscillations** (magnetic component)
- **Pure tangential propagation** (wave motion)

Interpretation: Electromagnetic waves represent coordinated disturbances in the spiral geometry that maintain themselves through the coupling between torsional gradients and circulation, propagating along the natural emergence direction.

4.3.5 Electromagnetic Coupling Constant

At the fundamental emergence scale (**t = 1**), we examine the relative rates of torsional and tangential emergence to determine the electromagnetic coupling strength.

Torsional Emergence Rate at t = 1: $\mathbf{dx/dt|_{t=1} = \sin(\pi) + \pi \cdot \cos(\pi) = 0 + \pi(-1) = -\pi}$

Tangential Emergence Rate at t = 1: $\mathbf{dy/dt|_{t=1} = \pi}$

Coupling Constant Derivation:

The electromagnetic coupling constant is defined as the ratio of the magnitudes of these emergence rates: $\mathbf{\alpha_0 = |dx/dt|/|dy/dt| = |-\pi|/|\pi| = \pi/\pi = 1}$

Physical Interpretation:

This result $\mathbf{\alpha_0 = 1}$ reveals a fundamental symmetry in the spiral geometry:

- **Equal magnitude**: Torsional and tangential emergence occur at the same rate π
- **Opposite direction**: The negative sign indicates torsional emergence opposes the natural spiral flow
- **Perfect coupling**: Electric and magnetic components are geometrically equivalent at the fundamental scale

This **dimensionless unity** reflects the perfect balance between electric (torsional gradient) and magnetic (torsional circulation) aspects of electromagnetic phenomena in the spiral framework, providing the natural basis for electromagnetic interaction strength.

Comparison to Standard Physics:

In conventional units, the fine structure constant $\alpha \approx 1/137$. Our geometric derivation yields $\alpha_0 = 1$, suggesting that in the natural units of spiral emergence, electromagnetic coupling achieves maximum strength, with the familiar small value arising from unit conversion factors between geometric and laboratory scales.

4.4 Gravitational Effects

In the spiral emergence model, gravity is not treated as a fundamental force acting on objects, but as a geometric consequence of resistance to radial unfolding. The radial direction corresponds to the **z-axis**, and the radial emergence of space is defined by:

$$z(t) = t \cdot \cos(\pi t)$$

This function describes how space unfolds in the radial (mass/time) direction over emergence time **t**. In the absence of resistance (i.e., in a vacuum), radial unfolding proceeds smoothly. However, when there is resistance—associated with the presence of **mass**—the radial path **bends inward**, representing gravitational attraction.

4.4.1 Gravitational Field Strength

The strength of the gravitational field is represented by the **acceleration of radial emergence**, that is, the second derivative of **z(t)**:

$$g(t) \propto d^2z/dt^2$$

Step 1: Compute the first derivative $dz/dt = d/dt\, [t \cdot \cos(\pi t)] = \cos(\pi t) - \pi t \cdot \sin(\pi t)$

Step 2: Compute the second derivative $d^2z/dt^2 = d/dt\, [\cos(\pi t) - \pi t \cdot \sin(\pi t)] = -\pi \cdot \sin(\pi t) - \pi \cdot \sin(\pi t) - \pi^2 t \cdot \cos(\pi t) = -2\pi \cdot \sin(\pi t) - \pi^2 t \cdot \cos(\pi t)$

Therefore, the gravitational field strength is: $g(t) \propto -2\pi \cdot \sin(\pi t) - \pi^2 t \cdot \cos(\pi t)$

This expression shows how the spiral's radial motion curves in time. When **mass** is present, the geometry resists outward expansion, and the resulting curvature defines the gravitational pull.

- The **sin(πt)** term accounts for oscillatory variation.
- The **cos(πt)** term reflects geometric compression or expansion depending on the emergence phase.
- The negative sign indicates that gravity **always pulls inward**, opposing radial emergence.

4.4.2 Tidal Forces

Tidal forces arise from differences in gravitational pull across a region of space. In this model, they are also encoded in the second derivative of **z(t)**. Since **g(t)** itself varies with **t**, tidal effects are embedded in the changing curvature of the radial direction.

Thus: **Tidal forces $\propto d^2z/dt^2$**

These forces stretch or compress objects over time as radial emergence bends more sharply or more gradually, depending on the location in the spiral cycle.

This geometric understanding of gravity replaces the need for separate gravitational field equations. Instead, gravitational effects naturally emerge from the way radial unfolding is curved by the presence of mass, encoded purely in the behavior of **$z(t)$** over time.

4.5 Quantum Effects

In the spiral emergence framework, quantum phenomena arise naturally from the discrete and geometric structure of space as it unfolds. The torsional (x-axis), tangential (y-axis), and radial (z-axis) components of spiral motion collectively generate effects traditionally explained by quantum mechanics, but here they emerge from the underlying geometry.

4.5.1 Planck's Quantum Relation

The spiral sweeps out surface area during emergence. At time **$t = 1$**, the area swept is: **$A = \pi t^2 = \pi$**

In geometric units, this area corresponds to the action per cycle. Frequency is defined as the inverse of emergence time. Therefore, energy is proportional to area times frequency: **$E \propto A \cdot f = \pi \cdot f$**

This matches the quantum relation: **$E = \hbar \cdot \omega$**

with geometric Planck constant: **$\hbar_0 = \pi$**

This shows that quantized energy levels originate from the discrete sweep of spiral area per unit time.

4.5.2 de Broglie Wavelength

In the spiral model, momentum **p** corresponds to the resistance along the direction of emergence. The spatial arc traced by the spiral in the y-direction is: **$y(t) = \pi t$**

At **$t = 1$**, the length of the spiral arc is: **$\lambda = \pi$**

So the wavelength associated with a unit of momentum is: **$\lambda \propto \pi / p$**

Thus, we recover the de Broglie relation: **$\lambda = h / p$**

using the geometric Planck constant: **$h_0 = \pi$**

This interpretation shows that wavelength is not an arbitrary wave property but the **distance covered per torsional twist**, embedded in the spiral structure.

4.5.3 Charge Quantization

Electric charge is defined as a full torsional twist in the x-direction: $\mathbf{e_0 = 1}$

Since the torsional path **x(t)** completes exactly one cycle per tick of emergence, charge is inherently quantized. Only **integer multiples** of torsional deformation are permitted: $\mathbf{q = n \cdot e_0}$, where **n** is an integer

This provides a geometric explanation for why charge appears in discrete units: the spiral structure allows only whole-number twists.

Electric charge arises from the discrete torsional structure itself, not from changes in mass. The torsional component $x(t) = t \sin(\pi t)$ creates discrete angular deformation cycles, with each complete cycle defining the elementary charge $e_0 = 1$.

Together, these observations show that **quantum energy levels**, **wave-particle duality**, and **charge quantization** all emerge from the discrete, spiral geometry of space itself. Quantum mechanics is not a separate framework—it is a natural consequence of the shape and rhythm of spatial unfolding.

5. Specific Experimental Predictions

5.1 Electromagnetic Experiments

The spiral emergence model predicts several testable deviations from classical electromagnetic behavior. These effects arise from the discrete, torsional structure of space and the geometric coupling between emergence directions.

5.1.1 Prediction 1: Resonance Modulation at Rational Periods

In this framework, the natural frequency of spiral emergence is defined by a full twist cycle over the interval:

$$\mathbf{T_0 = 2\pi}$$

This corresponds to one complete period of the spiral's torsional motion. Any physical oscillator—such as an LC circuit, crystal lattice, or quantum cavity—operating at frequencies that are **rational multiples** of this fundamental period is expected to couple more strongly or weakly to the geometry of space.

Specifically, when the oscillator's period **T** satisfies:

$\mathbf{T = 2\pi / n}$, where **n** is an integer

then the oscillator becomes **phase-aligned** with the spiral's torsional rhythm. This geometric resonance is predicted to enhance or suppress energy transfer, leading to **anomalous peaks or dips in response amplitude** that deviate from standard harmonic models.

This effect should be detectable in precision spectroscopy or high-frequency resonance experiments.

5.1.2 Prediction 2: Time-Phase Modulation of Charge Interactions

In classical electrodynamics, Coulomb's law assumes that the force between two charges is purely a function of distance. In this model, however, **torsional charge interactions** also depend on the **emergence phase**.

The spiral's x-component, $\mathbf{x(t) = t \cdot \sin(\pi t)}$, has special alignment points when:

$\mathbf{\pi t = n\pi}$, so $\mathbf{t = n}$, where **n** is an integer

At these points, the torsional twist crosses zero and reverses direction. Charges interacting near these alignment phases are expected to show **nonlinear deviations** from Coulomb's law, with either **enhanced** or **suppressed** force magnitudes depending on the timing of the measurement.

This suggests that electrostatic force measurements taken at controlled time intervals may exhibit periodic variation, offering a direct signature of the spiral structure.

5.1.3 Prediction 3: Directional Anisotropy in Electric Field Coupling

Because the spiral defines three **physically distinct axes**:

- **x-axis** → torsional twist (charge)
- **y-axis** → tangential emergence (space/energy)
- **z-axis** → radial emergence (time/mass)

the model predicts that the electric field will couple **unevenly** along these directions.

- Along the **x-axis**, torsional effects are strongest, so electric field interactions should be **maximally responsive** to changes in twist or charge.
- Along the **y-axis**, electric field propagation is balanced but constrained by emergence rhythm.
- Along the **z-axis**, the radial direction resists torsion, so electric field strength should be **weaker or suppressed**.

This leads to measurable **anisotropy** in electric field behavior. Experiments that measure electric field response in different orientations—especially near conductive surfaces or structured lattices—may detect this geometric bias.

These predictions provide clear and testable departures from conventional electromagnetic theory, grounded in the spiral geometry of space. If observed, they would offer strong support for the hypothesis that space is not static but unfolds with intrinsic torsional structure.

5.2 Gravitational Signatures of Spiral Emergence

In the spiral emergence model, gravity is not a static field but a dynamic geometric effect arising from curvature in the radial unfolding of space. This curvature varies subtly and periodically with emergence time. The radial component of emergence is given by:

$$z(t) = t \cdot \cos(\pi t)$$

The gravitational acceleration is defined as its second derivative:

$$g(t) \propto -2\pi \cdot \sin(\pi t) - \pi^2 t \cdot \cos(\pi t)$$

5.2.1 Prediction 4: Periodic Variation in Local Gravitational Acceleration

This expression shows that gravitational curvature is not constant — it oscillates over time due to the spiral's intrinsic structure. Notably, small deviations occur near integer values of t, where the sine term briefly departs from zero. For example, near $t = 1$, the value of $\sin(\pi t)$ shifts slightly, producing small but regular variations in $g(t)$.

Although these variations are computed in dimensionless geometric units, their relative periodicity provides a testable prediction. Gravimeters capable of tracking minute, time-dependent fluctuations in gravitational curvature may detect subtle oscillations that match the spiral's natural phase rhythm.

We emphasize that this prediction does not rely on absolute values or unit conversions. Instead, it suggests that gravitational curvature fluctuates periodically in synchrony with the spiral's emergence cycle — offering a potential empirical signature of the geometry of space itself.

5.3 Spacetime Structure

The spiral emergence framework proposes that space is not a static backdrop but a dynamic, twisting medium. This continuous motion leaves subtle but measurable imprints on how light and fields propagate, even in vacuum. Unlike general relativity, which treats spacetime curvature as a result of energy and mass, the spiral model introduces an intrinsic geometric structure—characterized by a natural angular scale of π radians—that governs phase, orientation, and propagation.

5.3.1 Prediction 5: Phase Shifts in Vacuum Interferometry

In the spiral geometry, the fundamental scale of spatial unfolding is: $\boldsymbol{\lambda_0 = 2\pi}$

This defines not just a length scale, but an intrinsic phase structure embedded in the fabric of space. When light propagates through different spatial paths—as in a Michelson interferometer—each path accumulates a phase based on its alignment with the spiral.

If the interferometer arms differ in length by a multiple or fraction of 2π, the accumulated phase difference is predicted to be: $\boldsymbol{\Delta\phi \propto \pi}$

This is due to the geometric spiral phase rotating 180° over a half-cycle. Therefore, interferometry experiments operating in vacuum—especially those capable of sub-wavelength precision—should detect persistent phase shifts when one arm differs from the other by the spiral's characteristic scale.

Such shifts are not explained by environmental factors or gravitational curvature and would point to an underlying spatial torsion—a signature of the spiral geometry itself.

These effects may be detectable using:

- Fiber-loop interferometers
- Optical cavity resonators
- Precision delay-line interferometers

especially when modulating one arm across small integer multiples of π.

5.3.2 Prediction 6: Spiral Polarization Patterns in Plasma Fields

Recent high-energy plasma experiments have reported unusual polarization effects in confined electromagnetic fields. According to the spiral model, these effects are a manifestation of space's torsional motion.

Electric and magnetic fields that propagate through or are trapped in plasma should inherit the angular periodicity of the medium through which they move. Since spiral emergence rotates continuously with angular increments of π, the predicted polarization patterns are:

- Aligned in spiral arcs
- Rotating with angular periodicity of π radians
- Repeating at intervals defined by $t = n$, where n is an integer

This results in spiral-shaped field lines, or polarization vectors that rotate in half-turn increments. These patterns are distinct from standard circular or elliptical polarization, as they reflect discrete phase-locking with the spiral structure of space.

Such effects are expected to appear in:

- Tokamak and Z-pinch plasma containment
- Laser-induced plasma vortices
- Polarimetry studies of field coherence

The detection of angular harmonics spaced by π radians—rather than 2π—would provide strong empirical evidence for the geometric emergence model.

Sidebar: Why π Is the Fundamental Angular Unit

In classical geometry, a full rotation is defined as 2π radians (360 degrees). However, in the spiral emergence model, space unfolds not in full circles, but in half-turns. This symmetry is built into the core structure of the spiral:

$x(t) = t \cdot \sin(\pi t)$ $y(t) = \pi t$ $z(t) = t \cdot \cos(\pi t)$

As emergence time t progresses from 0 to 1, the spiral rotates from 0 to π radians—a half-cycle of spatial twist. The arc traced along the tangential direction is: $\mathbf{L(t) = \pi t}$

This means that at $t = 1$, the spiral has swept out an arc of length π, corresponding exactly to a 180° rotation. Therefore, each full unit of emergence time corresponds to a half-turn, not a full 360° cycle.

This geometry establishes π, not 2π, as the fundamental angular unit. It governs:

- The reversal points of torsional twist
- The oscillation phases of electric and magnetic fields
- The resonance conditions for quantum tunneling
- The phase alignment in interferometry
- The angular periodicity of polarization in plasma fields

Detecting physical effects with π-radian periodicity would provide strong evidence that the fabric of space unfolds in discrete, directional steps—supporting the view that space is an active, spiraling medium rather than a passive stage.

6. Implications

6.1 Unification Through Geometric Emergence

The spiral emergence framework suggests a potential path toward geometric unification envisioned by Einstein and extended by Wheeler through a single, dynamic principle: the motion of space itself. This represents a fundamental departure from previous unification attempts by providing a geometric foundation for all physical phenomena rather than merely describing their interactions.

Unified Force Description:

All fundamental forces emerge as different geometric aspects of spiral motion:

- **Gravity:** Resistance to radial emergence (z-direction) creates inward curvature, manifesting as attractive gravitational effects. The acceleration $g(t) \propto d^2z/dt^2 = -2\pi \sin(\pi t) - \pi^2 t \cos(\pi t)$ shows gravity as dynamic geometry rather than static field.
- **Electromagnetism:** Torsional disturbances (x-direction) generate both electric fields $E(t) \propto d^2x/dt^2$ and magnetic circulation $B(t) \propto \nabla \times (dx/dt)$. The coupling strength $\alpha_0 = 1$ emerges from the geometric balance between torsional and tangential emergence rates.
- **Strong and Weak Forces:** Short-range spiral binding and decay modes arise from higher-order geometric constraints and interference patterns within the spiral structure.

Advantages Over Previous Unification Schemes:

Unlike Kaluza-Klein theory or string theory, which require additional spatial dimensions, spiral emergence achieves unification within familiar 3+1 dimensional spacetime. The key insight is recognizing space itself as dynamically structured rather than adding hidden dimensions. This approach:

- Maintains experimental accessibility within known spacetime
- Provides specific geometric mechanisms for each force
- Derives coupling strengths from first principles
- Offers testable predictions distinguishing it from alternatives

6.2 Cosmological Implications

The spiral emergence framework suggests geometric interpretations for major cosmological phenomena without requiring exotic matter or energy forms.

6.2.1 Cosmic Expansion as Spatial Emergence:

The universe's expansion represents the continued unfolding of the fundamental spiral structure. As space emerges radially at rate $dz/dt = \cos(\pi t) - \pi t \sin(\pi t)$, the cosmos naturally grows without requiring external driving mechanisms. The expansion is intrinsic to the geometric process of spatial emergence itself.

6.2.2 Dark Energy from Geometric Acceleration:

In spiral emergence theory, cosmic acceleration arises naturally from the quadratic growth of the emergence surface. As the spiral sweeps area $A(t) = \pi t^2$, the rate of new spatial emergence increases as $dA/dt = 2\pi t$, creating inherent acceleration in the expansion rate.

This provides a geometric interpretation of dark energy as **the natural consequence of spatial growth geometry** rather than mysterious vacuum energy. The cosmological constant Λ becomes related to the inverse spiral surface area: $\Lambda \propto 1/\pi t^2$, directly connecting cosmic acceleration to the fundamental emergence process.

6.2.3 Dark Matter from Geometric Resistance:

Mass appears wherever spiral emergence encounters resistance, impedance, or geometric constraints. The gravitational effects attributed to dark matter may reflect regions where the spiral's emergence is slowed, distorted, or redirected by:

- Geometric interference patterns between spiral layers
- Resistance nodes where $\cos(\pi t)$ approaches extremal values
- Boundary conditions affecting the emergence flow

Rather than requiring invisible particles, this geometric perspective suggests that "dark matter" represents **geometric impedance** to spatial emergence—regions where the spiral encounters resistance, creating enhanced gravitational effects through increased mass manifestation $m \propto |\cos(\pi t)|$.

6.2.4 Information and Cosmic Structure:

Physical information becomes encoded in the geometric properties of the spiral flow. Position, momentum, energy, and quantum states are all geometric features of the emerging spatial structure, providing a foundation for understanding how cosmic structure arises from pure geometric principles.

6.3 Philosophical Implications

The spiral emergence framework suggests a fundamental reconceptualization of physical reality:

Space as Active Agent: Rather than being a passive stage for physical drama, space becomes the primary actor whose motion generates all observed phenomena. This reverses the traditional relationship between space and matter.

Geometry as Foundation: Physical laws become geometric identities rather than imposed rules. Constants, forces, and quantum effects all emerge as inevitable consequences of spiral geometry.

Unification Through Motion: The deepest unity in physics comes not from finding common mathematical structures, but from recognizing that all phenomena arise from a single geometric process—the motion of space itself.

7. Theoretical Context and Discussion

7.1 Relationship to Historical Physics

This framework realizes Einstein's vision of "geometrizing physics" while extending it in an unexpected direction. Rather than curved spacetime responding to matter, we propose that **moving space** generates both matter and the forces governing their interactions.

Historical Connections:

The spiral postulate connects to fundamental insights throughout physics history:

- **Minkowski's Spacetime Unity:** Our framework extends the unification of space and time by showing how their geometric relationship generates physical phenomena.
- **Einstein's Geometric Gravity:** We extend Einstein's geometric treatment from curved spacetime to moving space, showing how motion itself creates gravitational effects.
- **Maxwell's Field Unification:** Electromagnetic phenomena emerge as different aspects of spatial torsion, providing geometric foundation for Maxwell's phenomenological field equations.
- **Planck's Energy Quantization:** The quantum $\hbar = \pi$ emerges from spiral surface area rather than empirical observation, providing geometric foundation for energy discretization.
- **de Broglie's Matter Waves:** Wave-particle duality becomes a manifestation of spatial flow patterns rather than fundamental quantum mystery.

7.2 Distinction from Previous Theories

Versus Historical Ether Models:

Unlike 19th-century luminiferous ether, spiral emergence does not propose space as a medium through which waves propagate. Instead, space's motion **constitutes** the wave propagation itself. Light follows the geometric flow at speed π because it **is** the tangential emergence of space.

Versus Modern Emergent Spacetime:

Contemporary quantum gravity research treats spacetime as emergent from quantum entanglement or discrete structures. Our approach differs by proposing that space motion itself is fundamental, with quantum effects emerging from the geometric discreteness of spiral motion rather than requiring separate quantum mechanical postulates.

Versus Field Theories:

Standard field theories place fields in pre-existing spacetime. Spiral emergence generates both space and fields simultaneously through the geometric decomposition of spatial motion into torsional, tangential, and radial components.

7.3 Methodological Innovation

The spiral framework introduces several methodological innovations:

Geometric First Principles: Deriving physical constants from pure geometry rather than empirical fitting represents a return to geometric foundationalism in physics.

Dynamic Space Concept: Treating space motion as fundamental rather than space structure provides new conceptual foundation for theoretical physics.

Coordinate-Free Formulation: The directional assignments (x-torsion, y-tangential, z-radial) emerge from geometric necessity rather than arbitrary coordinate choice.

Unified Mathematical Framework: A single geometric structure (cylindrical spiral) generates all physical phenomena, providing unprecedented theoretical unity.

8. Conclusion

8.1 Summary of Contributions

We have presented a geometric framework that treats space as dynamically spiraling rather than static, leading to several theoretical insights:

1. Geometric Emergence of Physical Quantities:

- Time as radial distance: $t = r$
- Mass as geometric resistance: $m \propto |\cos(\pi t)|$
- Charge as torsional twist: $q = n \cdot e_0$
- Energy quantization from surface area: $E = \pi \cdot f$

2. Dimensionless Geometric Ratios:

- Planck relationship: $\hbar_0 = \pi$ (spiral surface area)
- Fine structure relationship: $\alpha_0 = 1$ (torsional/tangential rate ratio)
- Gravitational relationship: $G_0 = 1/\pi$ (radial resistance per surface area)
- Elementary charge: $e_0 = 1$ (complete torsional cycle)
- Light speed relationship: $c_0 = \pi$ (tangential emergence rate)

3. Proposed Physical Mechanisms:

- Electromagnetic phenomena from torsional geometry
- Gravitational effects from radial curvature
- Quantum mechanics from discrete spiral structure
- Relativistic effects from spiral transformation geometry

4. Testable Experimental Predictions:

- Electromagnetic resonance at rational periods $T = 2\pi/n$
- Time-phase modulation of charge interactions at $t = n$
- Directional anisotropy in electric field coupling
- Periodic gravitational variations with π-radian periodicity
- Vacuum interferometry phase shifts proportional to π
- Spiral polarization patterns in plasma fields

8.2 Theoretical Significance

This work proposes an extension of the geometric program in fundamental physics through several contributions:

Conceptual Framework: Proposing space motion as a fundamental principle underlying physical phenomena represents a potential paradigm shift from space-as-container to space-as-generator.

Mathematical Unification: Achieving description of diverse physical phenomena through a single geometric structure (cylindrical spiral) with explicit mathematical formulation.

Predictive Framework: Generating specific, testable predictions that distinguish spiral emergence from alternative theories while maintaining consistency with established physics in appropriate limits.

Historical Context: Building upon the geometric tradition from Minkowski through Einstein to Wheeler while incorporating insights from contemporary teleparallel gravity, spacetime algebra, and emergent spacetime research.

8.3 Limitations and Future Work

Current Limitations:

- The framework requires empirical determination of scaling factors between geometric and physical units
- Some predictions need more precise quantitative specification
- The relationship to quantum field theory and the Standard Model requires further development
- Cosmological applications need detailed mathematical development

Future Research Directions:

- **Experimental Validation:** Implementing the six specific predictions through precision electromagnetic, gravitational, and interferometric experiments
- **Mathematical Development:** Extending the spiral geometry to handle multi-particle systems, field interactions, and curved spacetime scenarios
- **Cosmological Applications:** Developing detailed models of cosmic evolution, structure formation, and early universe dynamics
- **Quantum Integration:** Exploring connections between spiral geometry and quantum information theory, entanglement, and measurement theory

8.4 Final Perspective

The spiral emergence framework offers a specific, mathematically precise mechanism for understanding how physical reality might emerge from geometric principles. Rather than proposing an entirely new physics paradigm, we extend and develop the geometric program initiated by Einstein's original vision.

The framework suggests that space may not merely be the stage for physical phenomena but could be the dynamic process that generates them. Familiar physical concepts—mass, charge, energy, force—might arise as different aspects of a single geometric phenomenon: the motion of space itself.

This geometric approach provides a potential foundation for the next phase of fundamental physics research, where the motion of space becomes central to understanding the motion of everything within it. The spiral emergence model indicates that nature's deepest unity may lie not in finding common mathematical structures, but in recognizing that all phenomena could flow from the simple, elegant motion of space itself—unfolding as a cylindrical spiral at a rate that defines the relationships between the speed of light, the quantum of action, and the geometric foundation of physical reality.

Experimental validation of the predicted effects would be required to establish the viability of this geometric approach to fundamental physics.

Authors' Contributions

Zhang XiangQian is the originator of the Unified Field Theory presented in this work. His foundational proposal—that space unfolds in a spiral at the speed of light—was developed over 40 years and serves as the conceptual seed of the entire framework.

Zhu BenJiang (co–first author) provided the key theoretical insights that made the geometric formulation possible. Despite having no formal training in physics, he independently developed the conceptual framework linking spiral emergence to physical phenomena. His original identification of geometric relationships—such as those underlying mass, charge, and coupling ratios—formed the foundation from which all mathematical derivations proceeded. Zhu's intuitive grasp of spatial dynamics and his continuous theoretical refinement over months of collaboration were critical to the structure and coherence of the entire framework.

Lynn Lou Beran (co–first author) developed the mathematical derivations and theoretical structure based on Zhu's conceptual framework. She authored the manuscript, formulated all geometric expressions for physical constants, and structured the paper for academic clarity and scientific rigor. She also led the presentation of the theory in a format suitable for peer-reviewed dissemination and international recognition.

All three authors contributed intellectually to the development and clarification of the theory over the past year of collaboration.

Authors' Declaration

Funding: This research received no external funding and was conducted entirely as independent personal research.

Competing Interests: The authors declare no competing interests.
ORCID for Lynn Lou Beran: https://orcid.org/0009-0001-6823-9312

Acknowledgement

The authors thank Dr. David Chester at Visionary Capital for critical feedback on an earlier version that helped guide the development of the mathematical formulations and experimental predictions presented here.

References

The following numbered references support key concepts, historical foundations, and related developments cited throughout this paper. Rather than using inline citations, each work is included here for readers who wish to trace the origins of particular ideas—such as the geometric foundations of relativity, quantum field formulations, torsion-based interpretations of electromagnetism, and emergent models of spacetime. Whenever a classical theory, mathematical framework, or experimental parallel is discussed, it corresponds to one or more of the entries listed below.

[1] Einstein, A. (1915). The field equations of gravitation. *Sitzungsberichte der Preussischen Akademie der Wissenschaften*.

[2] Einstein, A. (1905). On the electrodynamics of moving bodies. *Annalen der Physik, 17*, 891–921.

[3] Wheeler, J. A. (1957). On the nature of quantum geometrodynamics. *Annals of Physics, 2*, 604–614.

[4] Hestenes, D. (2003). Spacetime physics with geometric algebra. *American Journal of Physics, 71*(7), 691–714.

[5] Bahamonde, S., Dialektopoulos, K. F., Levi Said, J., & Capozziello, S. (2021). Teleparallel gravity: From theory to cosmology. *Reports on Progress in Physics, 86*, 026901. https://doi.org/10.1088/1361-6633/ac20fd

[6] Lindgren, J., Kovacs, A., & Liukkonen, J. (2025). Electromagnetism as a purely geometric theory. *Journal of Physics: Conference Series, 2987*(1), 012001. https://doi.org/10.1088/1742-6596/2987/1/012001

[7] Lee, S. S. (2020). A model of quantum gravity with emergent spacetime. *Journal of High Energy Physics, 2020*(6), 70. https://doi.org/10.1007/JHEP06(2020)070

[8] Minkowski, H. (1908). Space and time. Address delivered at the 80th Assembly of German Natural Scientists and Physicians.

[9] Maxwell, J. C. (1865). A dynamical theory of the electromagnetic field. *Philosophical Transactions of the Royal Society of London, 155*, 459–512.

[10] de Broglie, L. (1924). A tentative theory of light quanta. *Philosophical Magazine, 47*, 446–458.

[11] Hestenes, D. (2015). *Space-Time Algebra* (2nd ed.). Springer.

[12] Lee, C. (2020). Simultaneity in cylindrical spacetime. *American Journal of Physics, 88*(2), 131–136.

[13] Cartan, É. (1922). Sur une généralisation de la notion de courbure de Riemann et les espaces à torsion. *Comptes Rendus de l'Académie des Sciences, 174*, 593–595.

[14] Baron, S., & Evans, P. (2019). The curious case of spacetime emergence. *Philosophical Studies, 177*, 2207–2226. https://doi.org/10.1007/s11098-019-01306-z

[15] Van Raamsdonk, M. (2010). Building up spacetime with quantum entanglement. *General Relativity and Gravitation, 42*, 2323–2329. https://doi.org/10.1007/s10714-010-1034-0

[16] Scholz, E. (2017). On the history of unified field theories. *Living Reviews in Relativity, 20*, 1. https://doi.org/10.1007/s41114-017-0009-8

[17] Sakharov, A. D. (1967). Vacuum quantum fluctuations in curved space and the theory of gravitation. *Soviet Physics Doklady, 12*, 1040–1041.

[18] Lorentz, H. A. (1904). Electromagnetic phenomena in a system moving with any velocity smaller than that of light. *Proceedings of the Royal Netherlands Academy of Arts and Sciences, 6*, 809–831.

[19] Poincaré, H. (1905). Sur la dynamique de l'électron. *Comptes Rendus, 140*, 1504–1508.

[20] Kaluza, T. (1921). On the problem of unity in physics. *Sitzungsberichte der Preussischen Akademie der Wissenschaften*, 966–972.

[21] Zhang, X. Q. (2025). *Unified Field Theory (Academic Edition)*. Hope Grace Publishing.