From Solitons to Strange Attractors: Chaos and Fractal Scaling of Matter in Binary Unified Theory

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For over a century, the quantum mechanics paradoxes of wave-particle duality and irreducible measurement uncertainty have been resolved only through abstract probability amplitudes and, for entanglement, an appeal to non-locality. This paper introduces the Binary Unified Theory (BUT), a strictly deterministic kinematic framework built from two zero-radius charges, the Poson and Negon, travelling perpetually at the universal speed c and interacting through a rigid, continuous $1/r$ field. Naturally tending to bind as opposing pairs, these charges form a stable two-body kinematic soliton: the photon, an $n = 2$ double helix uniting the particle and wave descriptions of light within a single deterministic trajectory. Introducing a third charge admits no general analytic solution, and the resulting $n \geq 3$ system transitions into non-linear, deterministic chaos, which will be shown to be the mechanical origin of mass, relativistic time dilation, and the Heisenberg Uncertainty Principle. The latter is redefined here as an epistemic measurement barrier rather than an ontological property of nature. Because the charges carry exactly zero radius, no two can ever coincide: as their separation $r \to 0$, the binding acceleration c^2/r diverges, dynamically excluding collision without invoking a repulsive core or finite particle size. This singular limit is shown to generate strange-attractor dynamics at every scale, and because the charges carry no intrinsic length, the resulting kinematic geometry is fractal, permitting structurally identical bound states from the scale of a proton to a galaxy, which differ only in their local rate of internal kinematic time. The same $1/r$ interaction is shown to reproduce the near-field confinement structure of the strong nuclear force directly, while an exact multipole treatment of the far field leaves Coulomb's law, between genuinely charged bodies, at the monopole exponent obtained directly from a single charged shell, an open problem in its own right, and narrows, without fully resolving, the corresponding problem for gravity between neutral bodies: no static geometry built by varying shell shape at a fixed center reaches the observed exponent, but a positionally displaced neutral construction does, exactly, leaving open only whether this framework's own neutral bound states realize it, a discrepancy we characterize precisely rather than obscure, sharply narrowing the search for its resolution.

I. INTRODUCTION

A. The Geometry of Wave-Particle Duality

The standard description of light rests on wave-particle duality, the historical reconciliation of Maxwell's continuous electromagnetic field [1] with Einstein's discrete light quantum [2]. This reconciliation requires the photon to be modeled as a dimensionless, structureless point particle whose evolution is governed by abstract probability amplitudes: wave-like during propagation and interaction, particle-like during emission and detection. The duality is thereby not resolved but encoded directly into the formalism, at the cost of denying the photon any explicit internal geometry or deterministic kinematic description.

This paper proceeds from a single premise: that the appearance of duality is a direct consequence of treating the photon as elementary, and that the paradox dissolves once light is instead modeled as a composite, classical structure obeying strictly deterministic kinematics. Sections II and III formalise this premise, deriving the wavelength, spin, and polarization of light from first kinematic principles rather than postulating them as intrinsic quantum properties.

B. Solitons of Light: A First Look at the $n = 2$ Photon

When exactly two fundamental charges of opposite sign interact, their mutual attraction cannot draw them together into a single point, since Axiom II forbids either charge from decelerating to rest. The pair is instead forced into a permanent, non-dispersive double-helical trajectory that neither collapses nor disperses, propagating indefinitely at speed c along its own axis. This $n = 2$ configuration is a genuine kinematic soliton, a localized, stable, and self-sustaining solution to the governing field equations, in the sense familiar from non-linear dynamics. Section III shows that this soliton reproduces the wavelength, spin, and polarization of light directly from its geometry, without recourse to a wavefunction.

C. Chaos Emerges

The soliton solution previewed above is a special case. The moment a third charge is introduced, the resulting three-body problem admits no closed-form solution, a result already established for continuous inverse-distance fields by Poincaré's analysis of the classical three-body problem [3]. Section IV shows that this transition from soliton to chaos is not a mathematical inconvenience but the mechanical origin of mass, time dilation, and the practical limits of measurement: every particle of matter heavier than the photon is, in this framework, a bound, deterministic, and irreducibly chaotic swarm of Posons and Negons.

D. Entanglement Without Spooky Action

The most demanding test of any local, deterministic framework is quantum entanglement, whose correlations are known to violate the inequalities derived by Bell under the assumption that a measuring device and the particle it measures can be treated as statistically independent systems [4]. Section VI shows that this assumption fails for every macroscopic detector in the Binary Unified Theory, since every detector is itself a chaotic swarm of the same charges and is never causally isolated from the field history of the particle it measures. Entanglement is thereby resolved without non-locality, restoring strict locality to the subatomic domain.

E. Structure of the Paper

Section II establishes the three axioms of the Binary Unified Theory. Section III derives the $n = 2$ photon soliton and its wave properties. Section IV extends the framework to $n \geq 3$ matter, deriving relativistic time dilation and the Heisenberg Uncertainty Principle as consequences of deterministic chaos. Section V addresses the zero-radius limit directly, showing that it excludes particle collision and imposes a fractal, scale-invariant geometry on all bound states. Section VI applies this framework to quantum entanglement, and Section VII derives the Coulomb, strong nuclear, and gravitational forces as geometric projections of the same underlying field. Section VIII concludes.

II. FUNDAMENTAL AXIOMS OF THE BINARY UNIFIED THEORY

A. Axiom I: The Binary Charges

All physical matter and radiation are macroscopic manifestations of exactly two fundamental entities, the Poson and the Negon, carrying equal and opposite charge and possessing exactly zero radius. Posons and Negons exist as discrete, localized points in three-dimensional space at every instant; they are never smeared across a probability distribution. Neither carries intrinsic mass. What is classically measured as mass is, in every instance, an emergent bookkeeping quantity, proportional to the internal kinematic energy of a bound configuration of these charges, and never a property carried by an isolated charge.

B. Axiom II: The Invariant Speed c

The speed of every Poson and Negon is fixed, absolutely and eternally, at the constant c, such that

$$|\mathbf{v}| = c.$$

Neither charge can accelerate to a higher speed, decelerate, or come to rest. Every force acting upon a Poson or Negon therefore performs no work in the ordinary sense; it can only rotate the direction of the velocity vector, never change its magnitude. Consequently, all mechanical energy carried by a bound system of charges, translational, rotational, and orbital alike, is a direct kinematic consequence of unceasing motion at this single invariant speed.

C. Axiom III: The Rigid $1/r$ Field and the One Force

Posons and Negons interact exclusively through a single, continuous, and eternal $1/r$ field, here termed the One Force. Because each charge is never accelerated in the ordinary sense, its associated field is not subject to the retardation delay expected of an accelerating source; measurements of highly relativistic, unaccelerated particle beams confirm that the field of a constant-speed charge moves rigidly in tandem with its source [5].

Because the fundamental charges possess no intrinsic mass (Axiom I), the One Force cannot be expressed as a force in the Newtonian sense of mass times acceleration; it is instead expressed directly as a kinematic constraint on acceleration. Confining a charge to a circular trajectory of radius r while preserving $|\mathbf{v}| = c$ requires, by classical centripetal kinematics, a transverse acceleration $a = v^2/r$; substituting $v = c$ fixes the fundamental acceleration field of the theory as

$$a = \frac{c^2}{r}.$$

This relation contains no reference to mass and applies identically to a single Poson or Negon at any interaction radius. Mass emerges only at the macroscopic level, as a proportionality constant relating this universal kinematic acceleration to an effective binding force. For a composite structure of emergent inertia m, the corresponding macroscopic force is

$$F = \frac{mc^2}{r},$$

which recovers the familiar form of the force binding kinematic structures together, while making explicit that mass is not a fundamental property of the Poson or Negon, but a derived measure of a composite structure's internal kinematic resistance to this universal acceleration field.

III. THE PHOTON AS A DETERMINISTIC KINEMATIC SOLITON

A. The Double-Helix Trajectory

Consider an isolated Poson-Negon pair. Their opposite charges attract under the One Force, and Axiom II forbids either charge from slowing to close their separation to zero. The attraction instead acts as a centripetal constraint, forcing the pair into a co-rotating orbit about a common axis while both charges continue to advance along that axis. The resulting trajectory is a stable double helix, in which the invariant speed c of each charge is partitioned into a forward propagation component v_z and a transverse rotational component v_t, related by

$$c^2 = v_z^2 + v_t^2.$$

This partition is the entire kinematic content of the photon: a single, deterministic trajectory that is simultaneously periodic in space, furnishing the wave description, and discretely bound, furnishing the particle description, with no additional postulate required.

B. Wave Properties from Classical Geometry

The rotational sense of the double helix, clockwise or counter-clockwise, fixes the sign of the photon's spin projection along its axis of propagation, reproducing the two observed states $+\hbar$ and $-\hbar$ with no admissible zero-spin state, since the charges must co-rotate to sustain their mutual attraction [6, 7]. The orbital radius r and transverse speed v_t fix the angular frequency $\omega = v_t/r$ of the helix; identifying the photon's energy with this rotation and substituting the Planck-Einstein relation $\omega = E/\hbar$ gives

$$r = \frac{\hbar v_t}{E},$$

so that higher-energy photons trace a tighter helical radius, a purely geometric account of the greater penetrating power of high-frequency radiation. The wavelength $\lambda = v_z T$ is the literal forward distance covered in one rotation of period T, phase is the instantaneous angular orientation of the pair, and polarization is the orientation of the rotational plane itself. The relativistic Doppler shift follows because a moving observer intersects the helix's periodic peaks at an altered rate, without the photon's own internal kinematics changing at all.

C. Stability and the Continuum of the Electromagnetic Spectrum

For the $n = 2$ soliton to support a continuous electromagnetic spectrum, it must remain stable at any orbital radius and rotational speed, rather than collapsing to one preferred geometry. Let m denote the effective inertia induced in each charge by its own orbital binding energy, an emergent quantity by Axiom I rather than an intrinsic property, and let the field attraction take the form $F' = k/2r$ for some constant k. Relativistic bookkeeping in the laboratory frame gives the centripetal requirement $F_c = mcv_t/r$ and the correspondingly weakened field attraction $F_{lab} = kv_t/2rc$. Equating the two, the radius r and speed v_t cancel exactly, leaving

$$k = 2mc^2,$$

independent of r and v_t. Because this cancellation holds at every combination of radius and frequency, the double helix is stable across a continuum of geometries, the kinematic precondition for an unbroken electromagnetic spectrum, and it fixes the binding force itself as

$$F = \frac{mc^2}{r},$$

identical in form to the One Force of Axiom III, showing that the photon's binding energy and the fundamental field share a single proportionality constant; this relation fixes the ratio between the two, though not either quantity independently.

This cancellation is not an incidental feature of the $1/r$ field; it is that field's unique signature. Repeating the derivation for a general power-law kernel $F' = \frac{k}{2}(2r)^{-n}$ gives the centripetal balance

$$mc^2 = \frac{k}{2^n}\, r^{1-n},$$

which is independent of r only when $n = 1$. Any steeper or shallower kernel would force every photon to a single preferred radius and frequency, eliminating the continuous electromagnetic spectrum observed in nature. A logarithmic kernel fails for an additional, independent reason: unlike a power law, it cannot be written without introducing a reference length scale, in direct conflict with the scale-free, fractal geometry established in Section V. The $1/r$ field of Axiom III is therefore not an assumed convenience but the only central-force kernel compatible with both a continuous spectrum and a scale-invariant universe.

D. Variable Propagation Velocity and Momentum Transfer

Because $c^2 = v_z^2 + v_t^2$ is fixed while v_t increases with photon energy, the forward propagation speed v_z must correspondingly decrease: higher-energy photons advance marginally slower than their lower-energy counterparts. This kinematic prediction is consistent with the reported 0.829 second delay between a 31 GeV photon and lower-energy emission from the same source after a transit of seven billion years [8], attributed here to the direct measurement of a v_z differential rather than to variation in the emission mechanism. The same partition explains momentum transfer without invoking a literal momentum carried by a massless particle: a high-energy photon's tightly wound, localized v_t component scatters chaotically into a struck target, in the manner of Compton scattering [9], dissipating as heat, while its structured v_z component delivers a synchronized translational impulse, recovering the classical flux description of Poynting [10]. Long-wavelength radiation, by contrast, possesses too diffuse a geometry to couple efficiently to matter, mechanically accounting for its comparatively weak interaction.

E. Emission Mechanisms: Antennas and Bremsstrahlung

Emission of an $n = 2$ pair is the mechanism by which an accelerated $n \geq 3$ swarm sheds excess internal kinetic energy to avoid kinematic collapse. In a radio antenna, a periodic alternating acceleration of the constituent charges sheds pairs continuously, in the manner described classically by Larmor [11], with higher drive frequencies compressing the internal kinematics and forcing the swarm to shed correspondingly tighter, higher-energy pairs. Bremsstrahlung is the extreme, instantaneous limit of the same mechanism: a charge violently deflected by a nucleus undergoes sudden kinematic compression and must shed a pair of extreme rotational speed, observed as a hard X-ray, the same classical parallel between macroscopic deceleration and microscopic radiation first suggested by Stokes and formalised by Thomson [12, 13]. In both cases the radiative energy of the emitted photon is set entirely by the severity of the acceleration that produced it.

IV. MATTER AS DETERMINISTIC CHAOS: THE N-BODY PROBLEM

A. The Electron as a Chaotic Attractor

Introducing a third interacting charge destroys the closed-form solubility of the $n = 2$ soliton. As in the classical three-body problem [3], any $n \geq 3$ system bound by a continuous field admits no general analytic solution and exhibits extreme sensitivity to initial conditions, the defining signature of deterministic chaos. The electron, and every other massive elementary particle, is modeled here as such a bound, chaotic $n \geq 3$ swarm. Because every constituent charge remains locked to the invariant speed c (Axiom II), the electron's mass is physically identified with the confined, purely internal chaotic motion of its constituents, giving direct mechanical content to the internal light-speed oscillation that Schrödinger identified formally in the relativistic Dirac electron [14].

B. Time Dilation as Kinematic Distance

Because the speed of light is a fixed ratio of distance to time, $c = ds/dt$, the passage of local time for any system is simply the integral of the internal path length traveled by its constituent charges,

$$t = \int \frac{ds}{c}.$$

For a macroscopic $n \geq 3$ system advancing through the vacuum at external speed v, Axiom II requires the absolute speed of every internal charge to remain c, so the internal chaotic speed u available for local interaction satisfies

$$c^2 = v^2 + u^2, \qquad u = c\sqrt{1 - \frac{v^2}{c^2}}.$$

As external speed v increases, less of each charge's invariant speed remains available for internal chaotic motion, so less internal distance is traveled per unit of external time, and local time passes more slowly by exactly the Lorentz factor $\gamma = c/u$. Time dilation is thus recovered as a literal mechanical deceleration of internal chaotic motion, and the same vector constraint accounts for length contraction and the divergence of inertia as $v \to c$, without invoking curved spacetime.

C. The Heisenberg Barrier: Chaos Disguised as Randomness

Despite its extreme internal complexity, an $n \geq 3$ swarm remains strictly deterministic: its phase-space evolution conserves volume under Liouville's theorem [15], so no information is destroyed, only scrambled across an increasingly intricate internal geometry. The appearance of fundamental randomness in quantum mechanics is attributed here to the physical impossibility of measurement: any laboratory detector is itself a macroscopic $n \gg 2$ chaotic swarm, and isolating its exact internal kinematic state without altering it is not achievable in practice. The Heisenberg Uncertainty Principle [16] is accordingly reinterpreted, not as an ontological limit on what nature permits, but as an absolute epistemic barrier imposed by the deterministic collision of one chaotic system with another.

V. SINGULARITY AVOIDANCE AND FRACTAL SCALE INVARIANCE

A. Zero-Radius Charges and the Exclusion of Collision

Because Posons and Negons possess exactly zero radius, their cross-section for direct physical impact is exactly zero, and two charges can never coincide. As their mutual separation r approaches zero, however, Axiom III requires the confining acceleration c^2/r to diverge without bound. This divergence, rather than any repulsive core or finite particle size, is what dynamically excludes collision: a would-be collision is preempted by an unboundedly large kinematic constraint before the separation can reach zero. All interaction therefore remains strictly field-mediated, momentum is exactly conserved in the sense of Newton's third law applied to the field itself, and the total number of fundamental charges in the universe, together with their total kinetic energy, is absolutely fixed.

B. Annihilation and Pair Production as Kinematic Reorganization

Because true collision is excluded, matter-antimatter annihilation cannot be a literal destruction of particles. An electron is modeled as an $n \geq 3$ swarm carrying a surplus of Negons, a positron as the equivalent surplus of Posons; when the two swarms intersect, their opposing fields neutralise and the freed charges reorganize directly into outgoing $n = 2$ soliton pairs, conserving every charge and every unit of kinetic energy. Pair production is the same process in reverse: because an $n = 2$ photon carries only two charges, it cannot spontaneously fracture in vacuum, and must instead deposit its energy into the chaotic field of a nucleus, which reorganizes into new bound $n \geq 3$ fragments. Both processes are kinematic reorganizations of a fixed charge population, never creation or destruction.

C. Fractal Self-Similarity Across Scale

Because Posons and Negons carry no intrinsic length scale, the stable geometric configurations that emerge from their $1/r$ interaction, whether the $n = 2$ helix or an $n \geq 3$ chaotic swarm, are independent of absolute size. An identical bound configuration is permitted at the scale of a proton or the scale of a galaxy; the sole physical distinction between them is the separation distance between constituent charges, which, by $t = \int ds/c$, fixes the local rate of internal kinematic time. Structurally identical patterns therefore recur across vastly different scales, with only their internal clock rate changing, a direct kinematic substitute for the geometric curvature invoked by General Relativity at cosmological scale.

D. Strange Attractors and the Architecture of Matter

Because constituent charges never collide and their phase-space evolution is volume-preserving, a bound $n \gg 2$ swarm carries an effectively unbounded internal information density confined to a bounded region of phase space, precisely the defining property of a strange attractor as formalised by Lorenz in the context of deterministic nonperiodic flow [17]. The stable boundary of a proton is one instance of such an attractor; extending the same geometry to cosmological scale allows a black hole to be modeled not as a singularity at which physical law breaks down, but as an extreme, bound $n \gg 2$ strange attractor, governed by the identical field mechanics that confine a single proton.

VI. RESOLVING BELL'S THEOREM THROUGH DETERMINISTIC CHAOS

A. Statistical Independence Reconsidered

Bell's inequalities are derived under the explicit assumption that the hidden variables of a particle are statistically independent of the measurement apparatus that will later interrogate it [4]. Bell himself observed that abandoning this assumption removes the need for nonlocality entirely [18]. Because every Poson and Negon projects an eternal, rigid $1/r$ field across the whole of space (Axiom III), no macroscopic detector can ever be truly isolated from the deterministic history of the particle it is built to measure; statistical independence is, in this framework, a physical impossibility rather than a simplifying idealization. This directly motivates the epistemic interpretation of the wavefunction [19], under which the wavefunction records an observer's ignorance of underlying deterministic variables rather than describing a physically collapsing entity.

B. The Kinematics of Entangled Pairs

An entangled pair produced by a common source, for instance by spontaneous parametric down-conversion, originates from a single localized $n > 2$ chaotic interaction and is emitted as two $n = 2$ solitons whose rotational phases are fixed identically at the moment of creation. As the two solitons propagate outward at speed c, their internal geometry remains fully determined and classically conserved; there is no interval of superposition to be resolved, only two deterministic trajectories sharing a common causal origin.

C. Measurement as Local, Deterministic Collision

When each $n = 2$ soliton subsequently reaches a spatially separated polarizing detector, itself a macroscopic $n \gg 2$ chaotic swarm, the resulting interaction is a strictly local, field-mediated collision rather than an instantaneous non-local collapse. Because the detector's chaotic internal geometry, including the experimenter's choice of measurement setting, is itself coupled to the same universal field history as the particle's creation, the correlations that violate Bell's inequalities are exactly what a fully field-connected, deterministic universe would be expected to produce. Bell's theorem is thereby bypassed not by abandoning locality, but by abandoning the assumption of statistical independence that the theorem requires.

VII. ONE FIELD, MANY FORCES: WHAT THE $1/r$ FIELD CAN AND CANNOT EXPLAIN

A. The Coulomb Monopole: An Exact Multipole Treatment

Consider a charged $n \geq 3$ swarm modeled, for tractability, as a uniformly populated spherical shell of radius a and net charge Q, observed from an external distance $R > a$. Because the fundamental interaction is $F = kqq'/r$ rather than an inverse-square law, its aggregate field cannot be obtained from Gauss's law, which is a special property of $1/r^2$ fields; it must instead be obtained by direct integration over the source. Parametrising the shell by the polar angle θ subtended at its center, with $s(\theta) = \sqrt{R^2 + a^2 - 2aR\cos\theta}$ the distance from a shell element to the test point, exact integration gives

$$F_{\text{shell}}(R) = \frac{kQ}{2R} + \frac{kQ(R^2 - a^2)}{4aR^2} \ln\left(\frac{R+a}{R-a}\right),$$

which we have confirmed by direct numerical quadrature. Expanded at $R \gg a$,

$$F_{\text{shell}}(R) = \frac{kQ}{R} - \frac{kQa^2}{3R^3} + O(R^{-5}).$$

The leading term is exactly $1/R$, for any shell radius, matching the elementary estimate obtained by summing individual $1/r$ contributions. A fundamentally $1/r$ interaction therefore produces a macroscopic monopole force that falls as $1/R$, not the observed $1/R^2$ Coulomb law. This is a genuine discrepancy of the framework as it stands, not a presentational gap, and we address it directly, together with its consequences for gravity, in Section VII.D.

B. The Strong Force as Near-Field Confinement

The short-range Yukawa potential historically invoked to describe nuclear binding [20] combines a $1/r$ term with an exponential suppression at long range. Within this framework, the $1/r$ term is simply the One Force itself, and the exponential suppression marks the geometric boundary of a densely packed $n \gg 2$ nuclear swarm, inside which the fields of closely confined charges add coherently and directly, without requiring any multipole reduction. The far-field behaviour beyond this boundary reduces to the same open monopole problem addressed in Section VII.A. No distinct strong interaction or mediating boson is required for the near-field confinement itself. Radioactive decay follows the same logic as a geometric threshold event, in which a swarm nearing critical internal instability sheds a fraction of its kinematic traffic and relaxes into a more stable resonant configuration.

C. Velocity-Correlated Binding: Why Some Configurations Resonate

Section VII.B describes densely packed confinement without deriving why any particular internal configuration should be preferred over another equally dense one. A minimal model isolates a candidate mechanism directly. Consider two constituents, each necessarily moving at c, in circular motion of radius a about separate centers displaced by R; the speed constraint fixes the angular velocity to $\omega = c/a$ for each, leaving relative phase and frequency as the only free parameters. When the two share both frequency and phase exactly, their instantaneous separation is constant and their time-averaged coupling is the full, undiluted k/r law evaluated at that fixed separation. When their frequencies differ, even by one part in 10^4, the coupling collapses toward the heavily diluted, shape-governed value obtained by direct numerical time-averaging of

$$\bar{F}(R) = \frac{1}{T}\int_0^T \frac{k}{|\vec{r}_B(t) - \vec{r}_A(t)|}\, dt,$$

which converges, for generic (uncorrelated) relative phase, to the static-shape results of Section VII.D and its companion notebook `coil_multipole_verification.ipynb` in the far field, and reaches up to forty six times that diluted value at close range under exact velocity matching (verified numerically in `resonant_path_overlap.ipynb`). The resonance is sharp rather than broad: only near-exact matching of velocity, not mere similarity, recovers the full undiluted coupling.

This gives a concrete, quantitative candidate mechanism for why a chaotic $n \geq 3$ swarm settles into discrete, favoured internal configurations rather than any arbitrarily dense arrangement. Constituents whose orbital motion happens to lock into shared frequency and phase experience dramatically stronger mutual coupling than constituents with merely similar but uncorrelated motion, so such velocity-locked subsets are the ones a chaotic system is kinematically driven to favour and retain as it explores its available configurations. The photon itself, the $n = 2$ double-helix pair of Section III, is the maximally resonant case of this mechanism, two constituents permanently phase-locked rather than merely coincidentally so, and its stability against the generic dispersive tendency of larger $n \geq 3$ swarms is consistent with the same principle. This mechanism strengthens coupling between resonant pairs; it does not alter the exponent of the underlying law, and the open problem of Section VII.D is unaffected by it.

D. Hadron Resonance without Quarks

The geometric classification of baryons and mesons established by Gell-Mann's Eightfold Way [21] is retained in full within this framework, but the subsequent proposal that these symmetries require fractionally charged constituent quarks [22] is not. Any continuous $1/r$ field bound in an $n \geq 3$ configuration settles naturally into discrete, resonant geometric configurations that maximise stability; the empirical patterns of the Eightfold Way are read here as the harmonic resonance modes of chaotic Poson-Negon swarms, made kinematically concrete by the velocity-locking mechanism above, recovering the structure of hadron physics without requiring unobservable fractional sub-particles.

E. Gravity and the Limits of Static and Velocity-Dependent Coupling

A macroscopically neutral $n \gg 2$ body carries an equal count of Posons and Negons, so its net monopole charge cancels exactly, and stable configurations of this kind are observed to consist of one charge species occupying an inner region and the opposite species occupying an outer region, executing only small internal displacements. We model this directly as two concentric shells, an inner shell of charge $-Q$ at radius a_1 and an outer shell of charge $+Q$ at radius $a_2 > a_1$, and evaluate the net force on an external test charge at $R > a_2$ by superposing two copies of the exact shell result of Section VII.A:

$$F_{\mathrm{net}}(R) = \frac{kQ}{4R^2}\left[\frac{R^2 - a_2^2}{a_2}\ln\left(\frac{R+a_2}{R-a_2}\right) - \frac{R^2 - a_1^2}{a_1}\ln\left(\frac{R+a_1}{R-a_1}\right)\right].$$

The $O(1/R)$ monopole terms cancel exactly between the two shells, as they must for a neutral body, and the leading surviving term at $R \gg a_2$ is

$$F_{\mathrm{net}}(R) = -\frac{kQ(a_2^2 - a_1^2)}{3R^3} + O(R^{-5}),$$

confirmed numerically to better than four significant figures in the local power-law slope. The residual force between two neutral, structured bodies therefore falls as $1/R^3$, not the observed $1/R^2$ of Newtonian gravity, whether the induced structure is treated as a static geometric shell or as a fluctuating multipole in the sense of London dispersion forces [23].

A further possibility is that some non-retarded, velocity-dependent modulation of the single-charge field, motivated by the relativistic beaming expected of a source moving at c, could restore the missing power of R. This does not succeed, for a reason that follows directly from Section IV's own characterization of $n \geq 3$ matter as chaotic. Let the field of a single moving charge carry an angular modulation $g(\psi)$, where ψ is the angle between its instantaneous velocity and the line to the field point. Because chaotic internal motion decorrelates each charge's velocity direction from its position on the shell, the modulation seen by a fixed external point, averaged over the chaotic motion, is

$$\langle g(\psi)\rangle = \frac{1}{2}\int_0^{\pi} g(\psi)\sin\psi\, d\psi,$$

a single constant independent of shell position. Any non-retarded, single-particle, velocity-dependent correction therefore reduces, under chaotic averaging, to a uniform rescaling of the coupling constant k and cannot alter the radial exponent obtained in Section VII.A.

A separate candidate is to abandon spherical symmetry itself. A bound Poson or Negon, always moving at c, traces a closed or quasi-closed path within a stable composite rather than occupying a fixed point, and a distant observer whose own relative motion evolves on a timescale far slower than this internal orbit would experience the time-averaged equivalent of a charge smeared along that path rather than along a shell. We test this directly for a uniformly charged ring of radius a, for which every point is equidistant from an on-axis test point and the force at distance R admits the closed form

$$F_{\mathrm{ring}}(R) = \frac{kQR}{(a^2 + R^2)^{(n+1)/2}},$$

confirmed against the textbook $n = 2$ on-axis ring field before evaluating it at $n = 1$. Expanded at $R \gg a$,

$$F_{\mathrm{ring}}(R) = \frac{kQ}{R} - \frac{kQa^2}{R^3} + O(R^{-5}),$$

identical in both leading and subleading powers of R to the shell result of Section VII.A, and the corresponding neutral, charge-segregated double ring reproduces the shell's $1/R^3$ exactly. A genuine three-dimensional helix, possessing none of the ring's residual axial symmetry and evaluated by direct numerical quadrature since no closed form is available, converges to the same two exponents, more slowly but unambiguously (verified in `coil_multipole_verification.ipynb`). This is expected on general grounds: the leading far-field term of any compact, linearly superposed source is fixed by its total monopole strength and the exponent of the underlying pairwise law, and the detailed shape of the source, spherical, ring-like, or helical, enters only the subleading correction terms.

The constructions above all cancel the monopole term by a difference of radius at a common center, and this choice of operation, not neutrality itself, is what fixes the result at $1/R^3$. The shell result of Section VII.A, expanded at $R \gg a$, is

$$F_{\mathrm{shell}}(R; a) = \frac{kQ}{R} - \frac{kQa^2}{3R^3} - \frac{kQa^4}{15R^5} - O(R^{-7}),$$

an even function of a/R, since only odd powers of $1/R$ appear; cancelling the leading R^{-1} term by a radius difference at fixed center therefore leaves R^{-3} as the next available term, never R^{-2}, regardless of the detailed shape used to do the cancelling. A positional displacement of an otherwise identical, oppositely charged shell acts on this series differently. For two shells of equal radius a, charge $+Q$ centered at $+\delta/2$ and $-Q$ at $-\delta/2$ along the axis to the test point, the ordinary electric dipole construction, the net force is

$$\begin{aligned} F_{\text{trans}}(R; a, \delta) &= F_{\text{shell}}(R - \delta/2; a) - F_{\text{shell}}(R + \delta/2; a) \\ &= -\delta \, \frac{\partial F_{\text{shell}}}{\partial R} + O(\delta^3), \end{aligned}$$

and differentiating a smooth function of R shifts its leading power by exactly one, whatever powers were present beforehand. Applied term by term to the series above,

$$\begin{aligned} \frac{\partial F_{\text{shell}}}{\partial R} &= -\frac{kQ}{R^2} + \frac{kQa^2}{R^4} + O(R^{-6}), \\ F_{\text{trans}}(R) &= \frac{kQ\delta}{R^2} + O(R^{-4}), \end{aligned}$$

recovering the observed R^{-2} exponent exactly, as an analytic consequence of the derivative relation rather than a numerical coincidence. This is confirmed to five decimal places by direct quadrature of the shell integral and, independently, by a discrete point-particle summation over the same construction, robust across displacement ratios δ/a from 0.001 to 0.9 (`translational_dipole_verification.ipynb`).

This narrows, rather than removes, the difficulty raised below. It shows that the failure of the constructions above is a property of the specific class tested, radius variation at a common center, rather than of static geometry in general, since a positional displacement of an uncancelled charge reaches R^{-2} directly. It does not show that this is the configuration this framework's own bound states form: those are observed here to segregate by radius around a shared center, which is the construction that fails, not the one that succeeds. A companion analysis [24] tests this directly on real simulated data, using the exact tracked member positions of an independently identified, real 14,385-particle bound cluster, and finds a persistent, non-cancelling dipole moment of the required kind, growing smoothly and holding its direction to within five degrees over its entire captured lifetime; the same analysis shows the $n = 2$ photon is structurally excluded from supplying this mechanism by an exact rotational cancellation tied to its own kinematic construction, robust under a two-axis, two-frequency generalization of its orbital motion. Nor do the two constructions combine by simple composition. Displacing two already-neutral, radially segregated shells by δ leaves the leading term at R^{-3}, unchanged in order, for identically oriented pairs, and worsens it to R^{-4} for oppositely oriented pairs, both confirmed numerically, because a positional derivative applied to a source with no remaining net charge has nothing left to act on. Recovering R^{-2} by this route requires the displacement to act on an uncancelled charge directly, not on a composite already rendered neutral by radial structure.

Recovering the observed $1/R^2$ scaling for gravity between neutral bodies and for Coulomb's law between charged ones are, on this evidence, distinct problems rather than one. The positionally displaced construction above applies only when the net charge is exactly zero: the monopole term of Section VII.A falls as $1/R$, and by linear superposition any additional dipole-like structure can only enter as a subleading correction to it, never as the leading term, whenever a genuine net charge remains. The gravitational case, between bodies with equal Poson and Negon counts, is therefore narrowed rather than resolved: the difficulty is not that no static, non-retarded geometry can produce R^{-2}, but that the geometry shown to do so has not been established as the one this framework's neutral bound states actually form. The Coulomb case, between bodies carrying an intrinsic charge imbalance, is not addressed by this result at all and remains at the $1/R$ monopole exponent obtained in Section VII.A, an open problem in its own right and, on the results above, a distinct one from the neutral case. Determining which geometry, or combination, real neutral composites exhibit is the most direct next step for gravity, and does not on its own require abandoning static geometry or non-retarded treatment; the Coulomb case has no comparable candidate at present. A first test of this question, on one real identified bound cluster rather than an idealized construction, is reported in the companion analysis cited above [24]; whether the same persistence holds generally, across different swarm compositions and over much longer timescales, remains open. Independently of both questions, a fully retarded treatment remains directly motivated by this framework's own axioms. Every constituent charge travels at exactly c, so treating its field as depending on its instantaneous rather than retarded position is not a small correction of the kind shown above to average away under chaotic motion, but potentially the dominant physics being discarded. A fully retarded, time-dependent treatment of the $n \geq 3$ swarm's own field has not been attempted here and is left for future work.

VIII. CONCLUSION

This paper has developed the Binary Unified Theory as a strictly deterministic kinematic framework built from two zero-radius charges, the Poson and Negon, moving eternally at the invariant speed c and interacting through a single rigid $1/r$ field. Bound in pairs, these charges form a stable, non-dispersive kinematic soliton identified with the photon; bound in three or more, they immediately admit no general analytic solution and settle into the deterministic chaos identified here with the mass, internal structure, and relativistic behaviour of ordinary matter. Because the fundamental charges carry exactly zero radius, physical collision is dynamically excluded rather than assumed away, and because they carry no intrinsic length scale, the resulting kinematic geometry is fractal, recurring identically from the scale of a proton to the scale of a galaxy. The same chaotic substrate is shown to underlie the Heisenberg Uncertainty Principle, reframed here as an epistemic measurement barrier rather than an ontological limit, and the violation of Bell's inequalities, resolved here through the failure of statistical independence rather than through non-locality. Finally, the strong nuclear force is recovered as a near-field confinement effect of this same field, while an exact multipole treatment of the far field separates two problems previously treated as one. Newtonian gravity, between neutral bodies, is narrowed rather than resolved: the radially segregated geometry observed in this framework's own bound states does not reproduce it, nor does any non-retarded, chaotically-averaged velocity coupling, but a positionally displaced neutral configuration is shown to reproduce the correct exponent exactly, so the open question is whether real bound states realize that construction rather than whether any static geometry could. Coulomb's law, between charged bodies, is untouched by this result, since a genuine net charge dominates the far field at the $1/R$ exponent obtained directly from the monopole treatment regardless of any internal displacement, and remains an open problem with no candidate resolution offered here. We take this to be a genuine narrowing of both problems rather than a resolution of either: whether this framework's actual neutral bound states realize the positionally displaced construction, some combination of it with radial segregation, or neither, remains open for gravity, the charged case remains open on separate grounds entirely, and a fully retarded treatment, motivated independently by every constituent charge travelling at exactly c, remains a candidate for both. Across every regime considered, the apparent randomness of the quantum domain and the apparent smoothness of the classical domain are shown to be two faces of the same underlying deterministic chaos.

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