BFUT Paper 17
The Emergence of Forces and Fundamental Senses
How the Spaticle Field Gave Rise to Gravity and All Other Forces

Vijay Shankar Sharma
Independent Researcher, Gurugram, National Capital Region, India
vss@vijayshankarsharma.com | ORCID: 0009-0001-9622-6121
The author declares no conflict of interest and no funding was received for this research.

Abstract

Within the Big Flare-Up Theory (BFUT), this paper derives the sequential physical emergence of all four fundamental forces from the physical matter substrate that pervades the universe, which the author names the Spaticle field, and identifies the order and mechanism by which each force arises. Gravity is derived as the substrate's mechanical restoring response to deformation by mass; this account connects directly to the modified gravitational field equations validated against 175 galaxy rotation curves in BFUT Paper 18. Charge is derived as the persistent rotational asymmetry of a compact condensation's internal Spaticle configuration, produced directly by the Paper 16 bifurcation, and electromagnetic propagation is derived as the time-varying polarised wave generated by an accelerating charge asymmetry travelling through the Spaticle medium. Five distinctive properties of electromagnetism, bidirectionality, long range, shieldability, finite propagation speed, and information richness, are derived from substrate physics with no additional postulates. The weak force is derived from a transformation-capable internal topology: the large substrate reorganisation energy required explains the mediating particles' mass, and parity violation is derived as a structural asymmetry in the direction of internal reconfiguration. The paper unifies the four forces within a single framework in which each force functions as a fundamental sensing channel, with formal definitions and testable predictions for the correspondence between physical force and informational sense. Paper 16 derives the equilibrium Spaticle-field density as $\rho_s = 7.3 \times 10^{-27}$ kg/m³; this paper uses the adopted working value $\rho_s = 7.3 \times 10^{-27}$ kg/m³.

Keywords: Spaticle field, gravity, strong force, electromagnetism, weak force, force emergence, signal channels, sensing, substrate deformation, charge asymmetry, rotational mode, parity violation, dark matter, flat rotation curves, modified gravity, quark, 3+e threshold

---

1. Introduction

Modern physics identifies four fundamental forces governing all known interactions: gravity, the strong nuclear force, electromagnetism, and the weak nuclear force. These have been described with remarkable mathematical precision. General relativity accounts for gravity at cosmological scales. Quantum chromodynamics describes the strong force. Quantum electrodynamics achieves the most precise numerical predictions in the history of science. The electroweak theory unifies electromagnetism and the weak force within the Standard Model. Despite these achievements, a foundational question has remained largely unaddressed: how did these forces come into existence, and why exactly these four?

In the Standard Model, the four fundamental interactions are represented as fundamental components of the theory. The framework describes their properties and effects with high mathematical precision and has successful predictive power, but it does not provide the BFUT account of their sequential physical emergence from a prior substrate. The BFUT proposal addresses that ontological question by treating the four interactions as different regimes of one physical substrate.

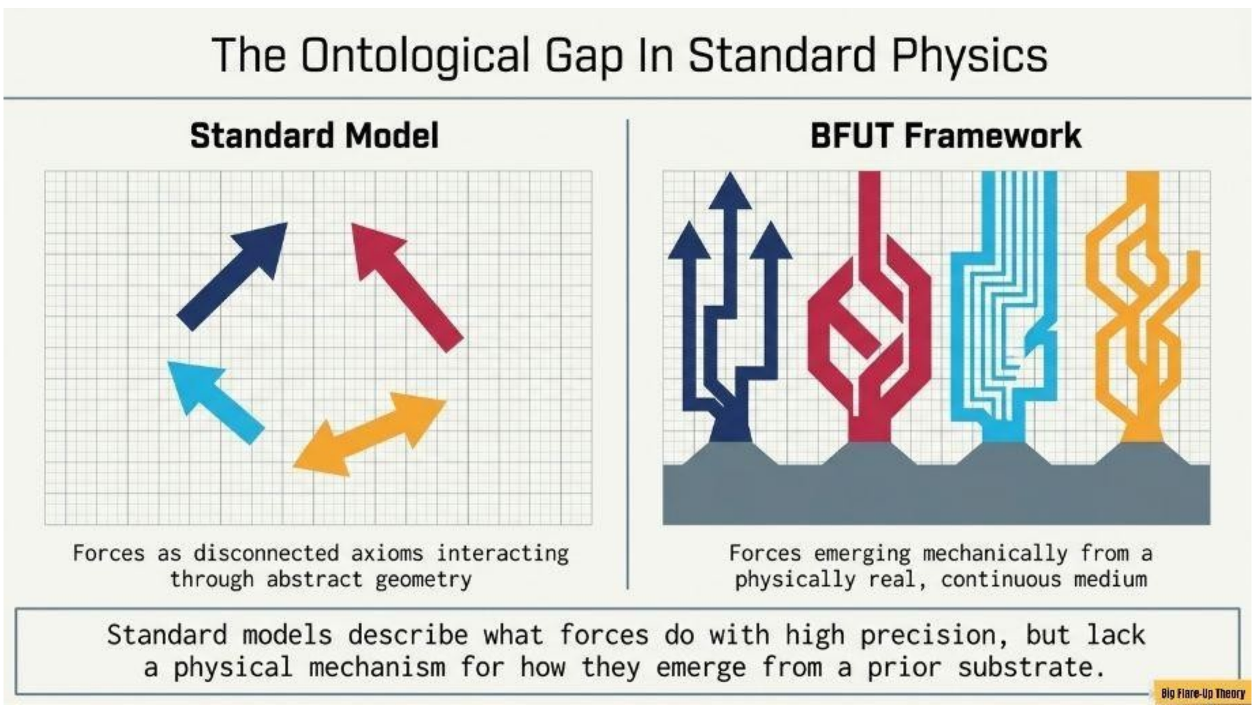

Figure 1. Standard model treats forces as axiomatic; BFUT derives them from substrate mechanics. [9]

This paper presents the BFUT account of force emergence. BFUT identifies a dense, space-filling matter substrate composed of matter-particles and permeating the infinite universe; the author names this substrate the Spaticle field. It is the physical referent of what general relativity describes geometrically. BFUT Paper 15 establishes the prior energy state of infinite space. BFUT Paper 16 derives the transition from the Spaticle field to stable quarks, protons, electrons, and hydrogen, with the complete derivation, robustness scans, and dynamic simulation code deposited at Zenodo. [5][6]

This paper derives how gravity and the other three fundamental forces emerge in sequence from the Spaticle field and establishes their common role as the fundamental sensing channels through which physical systems interact with their environment.

Three framing points govern this paper. First, the strong-force sections use the constructive results of Paper 16. Second, the electromagnetic and weak-force sections derive their mechanisms from Spaticle-field physics. Third, Section 8 establishes the force-sensing correspondence whose complete scientific framework is presented in BFUT Paper 20 (https://doi.org/10.5281/zenodo.19992457).

Section 2 presents the Spaticle-field properties relevant to force emergence. Section 3 derives gravity as substrate deformation. Section 4 summarises the modified gravitational equations and galaxy-rotation evidence, with the complete derivation in BFUT Paper 18. Sections 5 through 7 derive the sequential emergence of the strong force, electromagnetism, and the weak force. Section 8 establishes the force-sensing correspondence developed in Paper 20. Sections 9 and 10 present supporting literature and connections with prevailing models. Sections 11 and 12 present the resulting physical implications and their connection to BFUT gravitation and sensing results.

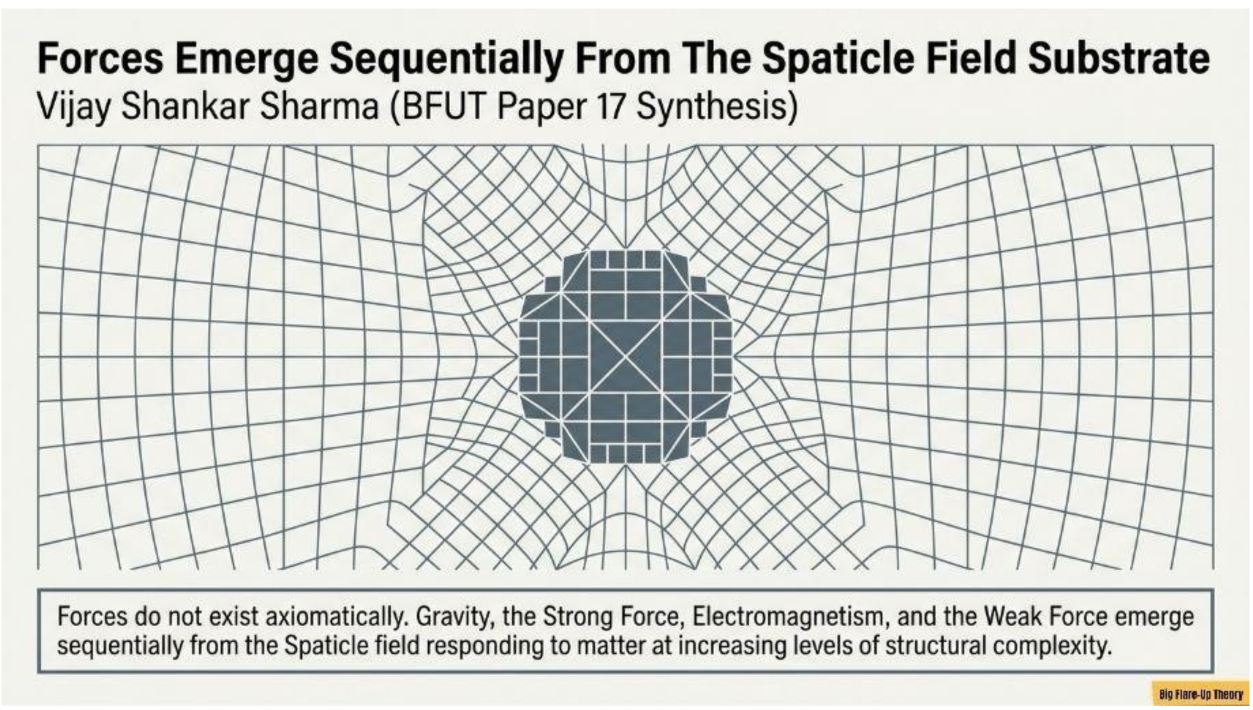

Figure 2. Sequential emergence of forces from increasing Spaticle field structural complexity.

The Big Flare-Up Theory identifies the physical matter substrate that pervades the infinite universe and names it the Spaticle field. Its equilibrium density is derived in Paper 16 and applied across the BFUT programme in cosmology, gravitation, particle physics, quantum mechanics, and the origin of matter and forces. The Spaticle field is a physical medium with measurable properties. BFUT identifies a single condensing field and excludes independent zero modes from the QFT vacuum mode sum, so the zero-point vacuum contribution collapses to zero. [4][5][6][9]

The Spaticle field is not the luminiferous ether. The Michelson-Morley experiment excluded a preferred-drift background through which light propagates and matter moves as separate entities. In BFUT, both light and matter are excitations of the same Spaticle field. Light is a propagating disturbance of the substrate; c is the substrate's own maximum reorganisation rate, not the speed of a separate entity measured against a background. No embedded observer can detect substrate-wide drift because all measuring instruments and all measured signals are excitations of the same medium. A person on a ship likewise cannot detect the ship's uniform motion by measuring distances between objects fixed to that ship. The Michelson-Morley null result is therefore the result required in a BFUT universe. The experiment cannot distinguish an absent substrate from a substrate in which light and matter are both excitations that obey the same locally Lorentz-covariant laws. The latter is the BFUT position. The complete argument is given in BFUT Paper 16, with light as a substrate excitation derived in Section 6.6 and BFUT Paper 19, Section 13. [6][9][11]

1.1 Symbols and Notation Used in This Paper

The following symbols are used throughout this paper. Values are from the BFUT Master Symbol Guide.

Symbol	Definition	Value / Expression
ρ_s	BFUT-constrained/adopted equilibrium density of the Spaticle field	7.3×10^{-27} kg/m³
Ψ(r,t)	Spaticle carrier field / gravitational potential	Reserved capital symbol for the Spaticle carrier field
λ_s	BFUT quartic Spaticle-field self-interaction coefficient	Fixed by the selected field normalisation
α / α_vss	Fine-structure constant	α = 1/137.036 measured; α_vss = 1/137.037 in the P17/P19 BFUT derivation
α_s / α_s_vss	Strong coupling constant	α_s = 0.118 at m(Z) scale; α_s_vss = 0.120 in the P17/P19 BFUT result
sin²θ_W_vss	BFUT electroweak mixing quantity	sin²θ_W_vss = 1 − (m_W_vss/m_Z_vss)² = 0.23257
R_0	P16 dimensionless condensation minimum	1.27348221
E_unit	P16 fundamental energy unit	$m_p \cdot c^2/\pi$
C_s	BFUT confinement coefficient used in P17	Fconf = 0.574 GeV/fm, as reported from the P19 Section 20.6 chain
a_s	Density-derived acceleration scale	$c\sqrt{G\rho_s/3} = 1.208 \times 10^{-10}$ m s^{-2}
G	Gravitational constant	6.674×10^{-11} m³ kg^{-1} s^{-2}
c / c	Speed of light / BFUT substrate propagation speed	c = 2.998×10^{8} m/s; c denotes the BFUT-derived mechanical form
κEM	Nonlinear directional-field self-interaction coefficient	Coefficient in the P17 electromagnetic directional-field equation
m_W_vss, m_Z_vss	BFUT-derived W and Z resonance masses	m_W_vss = 80.066 GeV/c²; m_Z_vss = 91.396 GeV/c²

2. The Spaticle Field: Physical Properties Relevant to Force Emergence

BFUT Paper 14 establishes the Spaticle field's identity and physical character. BFUT Paper 16 demonstrates that this substrate supports stable localised excitations through a free-energy functional with an interior minimum robust across multidimensional parameter scans. This section presents the properties directly relevant to force emergence.

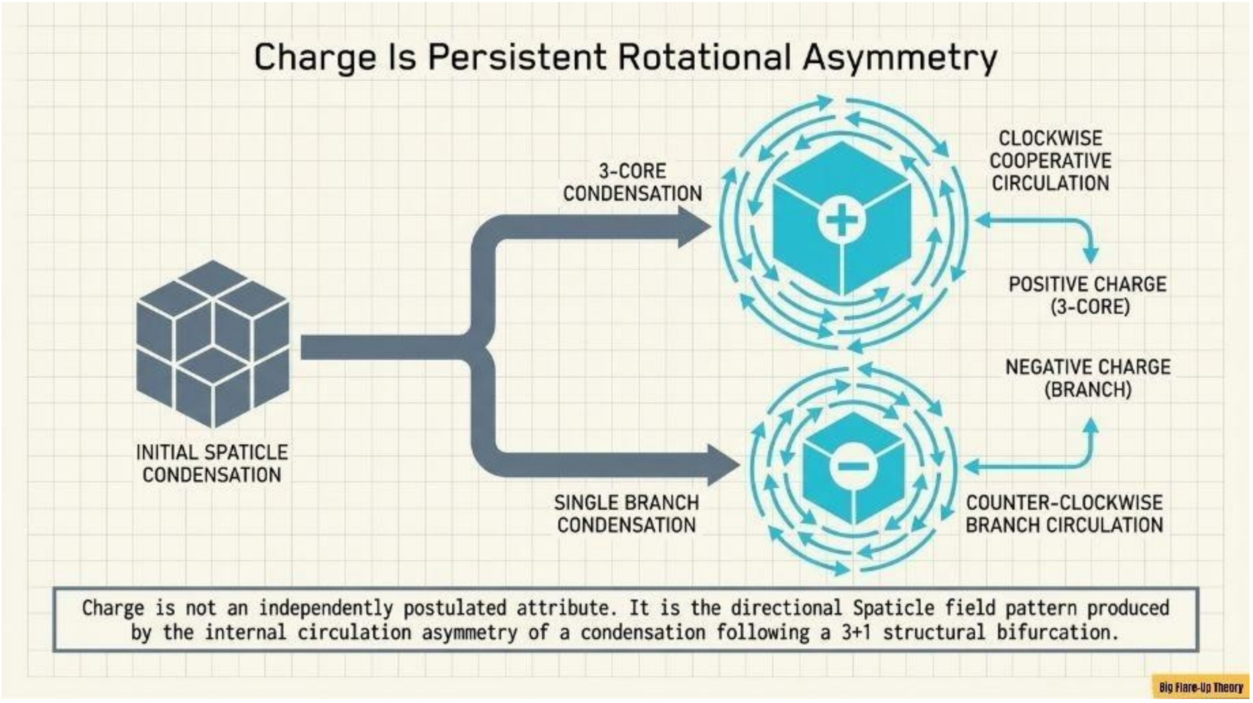

Figure 3. Charge as a directional internal circulation asymmetry, produced by 3+e structural bifurcation into positive and negative charge branches.

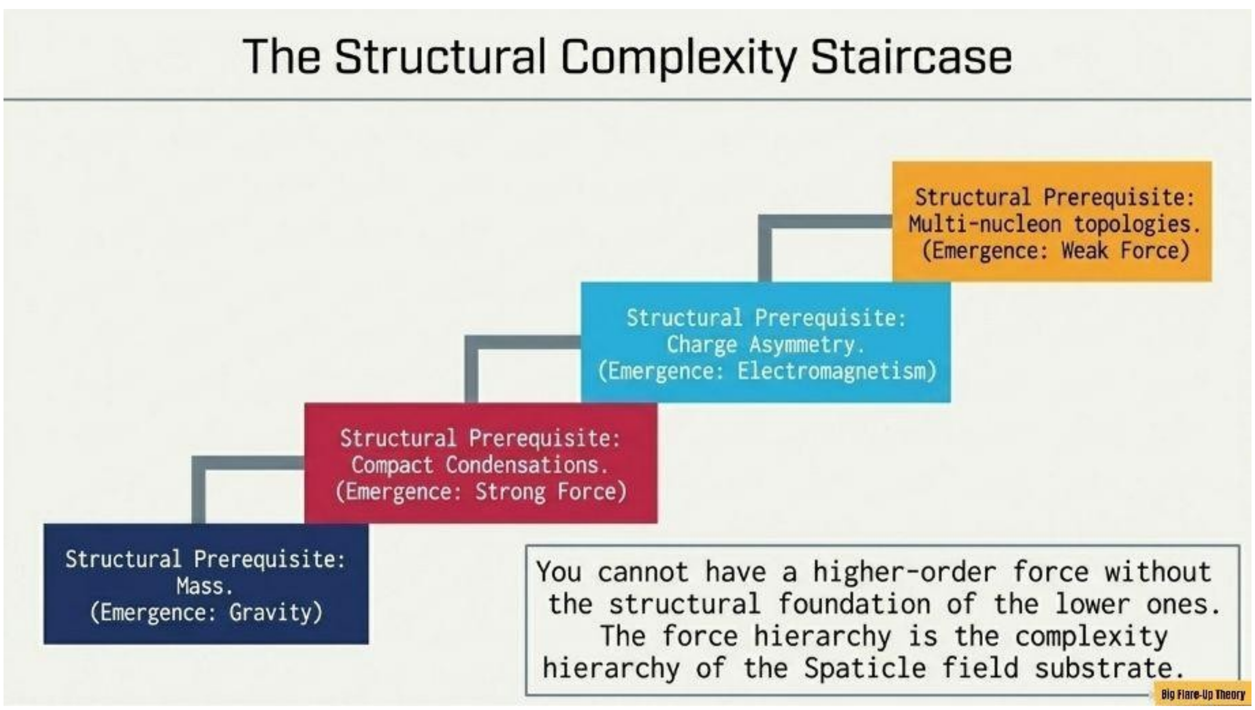

Figure 4. Structural prerequisites required for successive force emergence in the Spaticle field.

The Spaticle field is a dense, continuous substrate of matter-particles, Spaticles, populating the entire infinite universe. It is a physically real medium with definite density, compressibility, and dynamic response characteristics. BFUT Paper 16 presents the complete particle-sector derivation of the equilibrium density from the condensation functional through the gravitational self-energy density. [6]

Five physical properties of the Spaticle field are fundamental to the force-emergence analysis that follows. First, the field is space-filling: Spaticle particles resist local depletion and tend to occupy all available space. Second, the field is deformable: concentrated mass or energy displaces and compresses the local Spaticle configuration. Third, the field has a restorative tendency: when deformed, it generates a restoring gradient across the substrate. Fourth, the field supports propagating disturbances: changes in local Spaticle configuration propagate outward as waves at a maximum propagation speed determined by the medium's density and compressibility. Fifth, the field is the medium in which matter condenses: Paper 16 demonstrates that stable localised Spaticle excitations occupy an interior energy minimum, and repeated first units cross a 3+e threshold to yield a proton and an electron.

These five properties are not independently postulated for each force. They are the single underlying character of the Spaticle field from which all four forces emerge, each at a different level of structural complexity. The force hierarchy is a complexity hierarchy within one substrate, not a collection of independently instituted laws.

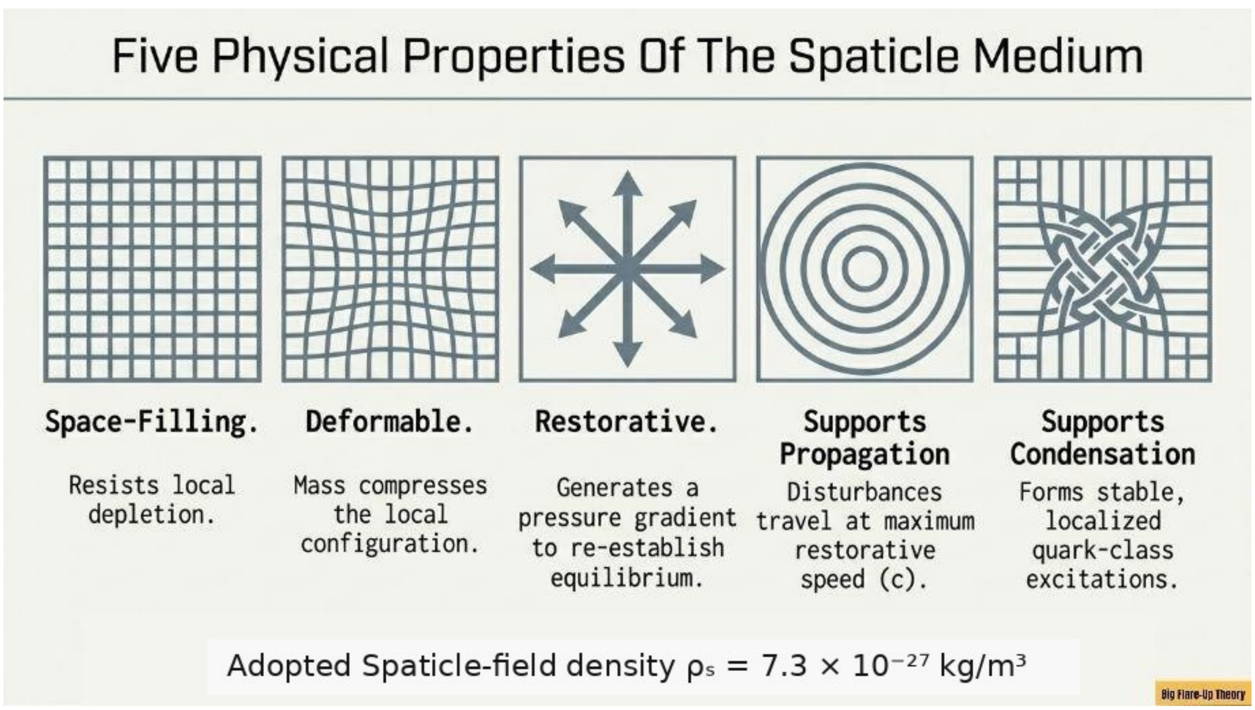

Figure 5. Core physical properties of the Spaticle field enabling deformation, restoration, and signal propagation.

The five properties follow from the Spaticle field's character as a real, dense, space-filling medium. They are mechanical consequences of this physical matter substrate and form the basis of the force-emergence analysis.

3. Gravity as the Inbuilt Mechanical Consequence of Spaticle Field Deformation

3.1 The Standard Account and Its Ontological Gap

General relativity describes gravity as spacetime curvature produced by mass-energy, with free bodies following geodesics in that curved geometry. This description is mathematically exact and observationally confirmed to extraordinary precision. But it carries an ontological gap: it specifies what spacetime does under the influence of mass without specifying what spacetime is, and without providing a physical mechanism by which curved geometry translates into a force experienced by matter.

BFUT interprets spacetime curvature as the geometric description of an underlying physical substrate state. In the BFUT account, geometric curvature corresponds to Spaticle-field deformation, and the experienced gravitational effect corresponds to the mechanical response of that deformed substrate.

3.2 The BFUT Substrate-Deformation Account of Gravity

Consider a concentrated mass introduced into the Spaticle field. That mass displaces and compresses the local Spaticle configuration. The field, being space-filling and resistant to local depletion, generates a restoring tendency: the substrate attempts to re-populate the displaced region, and this tendency propagates outward as a gradient of Spaticle pressure across the field.

Any other mass within range of this deformation gradient finds itself in a locally non-equilibrium Spaticle configuration. The equilibrium direction, toward which the Spaticle pressure gradient points, is toward the first mass. The second mass, immersed in this gradient, experiences a net force in that direction. That net force is gravity.

Gravity was inbuilt in the Spaticle field from the moment of its manifestation. The moment a real, dense, deformable, space-filling substrate existed, the conditions for gravitational interaction were already in place. Gravity required no separate creation or insertion as an independent law. It was already the mechanical consequence of mass deforming the existing substrate.

Universality follows directly: because all matter exists within the Spaticle field and every mass deforms it, every mass interacts gravitationally with every other. Unshieldability follows equally: there is no region outside the Spaticle field, so no mass can be placed beyond the reach of substrate deformation gradients. Gravitational waves follow naturally: an accelerating mass produces a time-varying deformation that propagates outward as a wave through the substrate.

Gravity is the mechanical sequence of Spaticle-field deformation produced by mass, the restorative pressure gradient generated by the field, and the resulting force on a second mass immersed in that gradient.

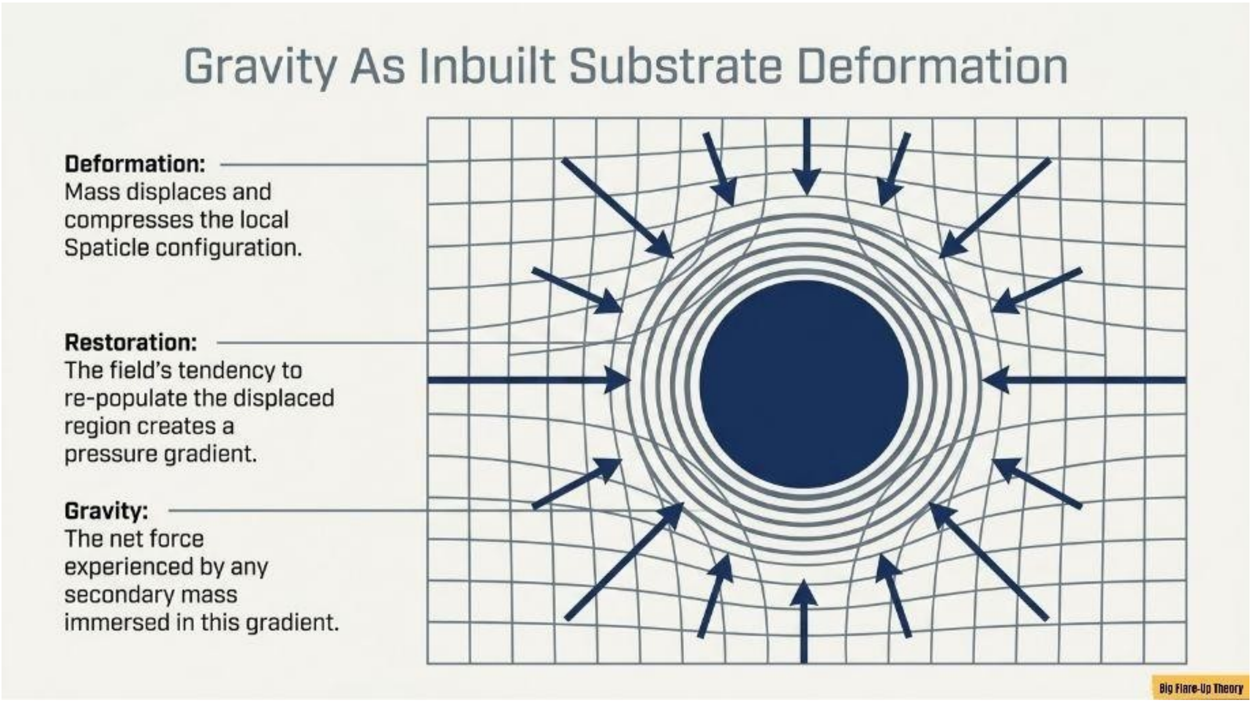

Figure 6. Gravity as inbuilt substrate deformation: mass displaces and compresses the local Spaticle configuration, and the field's restoring tendency generates the gravitational pressure gradient.

3.3 Why Gravity Is the First Force to Emerge

Gravity requires the least demanding structural prerequisites of the four forces: only the existence of mass within the Spaticle field. No bound state, charge configuration, internal particle structure, or transformation capability is required. When matter first condensed and ordinary hydrogen formed as established in BFUT Paper 16, gravitational interaction was immediately present. Gravity is the first mechanical consequence of matter existing within the physical substrate.

4. The Modified Gravitational Field Equations

4.1 Standard GR and the Source-Term Gap

Standard general relativity is governed by:

In standard general relativity, the source term $T_{\mu\nu}$ represents the stress-energy included in the model. BFUT identifies the Spaticle field as a physical matter substrate and includes its stress-energy contribution explicitly. In the outer regions of galaxies, the resulting field contribution sustains the observed gravitational response.

4.2 The Full Lagrangian

The covariant gravitational action combines the Einstein-Hilbert term, matter, the Spaticle scalar field, and their interaction:

$$S = \int d^4x \sqrt{(-g)} \, [c^4R/(16\pi G) + \mathcal{L}_m + \tfrac{1}{2}\partial_\mu\Psi\partial^\mu\Psi - V(\Psi) + \mathcal{L}_{int}(\Psi, \text{matter})]$$

The Spaticle field supports localised and propagating excitation modes, and its carrier response scale is $\mu_s^2 = 3G\rho_s/c^2$, derived in Paper 18. The kinetic term describes propagation of substrate deformation, and the quartic potential describes the field's internal resistance to compression and distortion. Matter sources the carrier field through the covariant gravitational potential developed in Paper 18. In the weak-field limit, this source reduces to the Poisson relation $\nabla^2\Psi(\text{matter}) = 4\pi G\rho(\text{matter})$. [7]

4.3 The Derived Stress-Energy Tensor and Full Field Equation

Variation with respect to the metric gives the combined matter and Spaticle stress-energy source. For $V(\Psi) = \lambda_s\Psi^4/4$, the Spaticle contribution is:

$$T_{\mu\nu}^{(s)} = \partial_\mu\Psi\partial_\nu\Psi - g_{\mu\nu}[\tfrac{1}{2}\partial_\alpha\Psi\partial^\alpha\Psi - V(\Psi)]$$

Energy and momentum exchanged between matter and the Spaticle field remain conserved in their combined stress-energy tensor. The full modified field equation is:

$$G_{\mu\nu} = (8\pi G/c^4)[T_{\mu\nu}^{(m)} + T_{\mu\nu}^{(s)}]$$

The total stress-energy tensor obeys $\nabla_\mu[T_{\mu\nu}^{(m)} + T_{\mu\nu}^{(s)}] = 0$. The interaction term transfers energy and momentum between matter and the Spaticle field while preserving conservation of their combined source. Paper 18 specifies the covariant matter potential that generates this transfer. [7]

4.4 The Coupling Structure

The weak-field limit connects the covariant field to the gravitational potential Ψ and the effective mass-density sources derived in Paper 18. [7]

In the weak-field, slow-variation limit, the covariant carrier equation F1-cov of Paper 18 reduces to:

$$\nabla^2(\delta\Psi) - \mu_s^2\delta\Psi = \kappa_s\nabla^2\Psi_{\text{matter}}, \quad \nabla^2\Psi_{\text{matter}} = 4\pi G\rho_{\text{matter}}, \quad \mu_s^2 = 3G\rho_s/c^2$$

Its static solution $\delta\Psi = -GM\, e^{(-\mu_s r)}/r$ recovers Newtonian gravity for $r \ll L_s = 1/\mu_s = 26.205$ Gly. [7]

The Spaticle carrier field is Ψ in both the covariant action and the weak-field description. Its normalisation and the conversion between field energy density ε_s and equilibrium mass density ρ_s

are fixed in Paper 18 by $\varepsilon_s = \rho_s c^2$. In the weak-field galactic regime, the resulting dark matter effects equation (DME) is expressed through $a_s = c(G\rho_s/3)^{1/2}$. The same ρ_s, G, and c therefore determine the extra gravitational response without a galaxy-fitted field constant. [7]

4.5 GR Recovery and Cross-Domain Consistency

In settled regimes, the carrier state tracks the source and the field equation reduces to standard general relativity. All precision GR tests are unaffected: perihelion precession, Shapiro delay, gravitational lensing by the Sun, binary pulsar orbital decay. In organised rotating systems, the compressed, rotating Spaticle medium supplies the extra gravity described by the dark matter effects equation (DME). The extra support is largest where the baryonic acceleration falls below a_s, as in galactic outer discs and low surface brightness galaxies. [7]

4.6 Empirical Results: Rotation Curves

The BFUT framework derives galaxy rotation curves from the DME equation of Paper 18. Organised extra gravity is

$$a_s = c\,(G\,\rho_s / 3)^{1/2} = 1.208 \times 10^{-10}\ \mathrm{m\ s^{-2}}$$

$$v^2(R) = v(b)^2(R)\,[1 + a_s\,R / v(b)^2(R)]^{1/2}$$

The field acceleration scale is fixed across the galaxy sample. The quantity Υ = 0.5 at 3.6 μm is the SPARC stellar mass-to-light ratio used to calculate the baryonic contribution.

SPARC Validation: 175 Galaxies, One Equation

Applied to all 175 galaxies in the SPARC database: shape agreement 92.0%, flat classification 98.8%, non-flat classification 14.3% (2/14), median outer relative residual 0.096. KiDS-1000 isolated-lens stacks use the same a_s.

The 92.0% shape agreement across 175 galaxies, with the acceleration scale computed from ρ_s, G, and c, is a reported empirical validation of the organised-extra-gravity result.

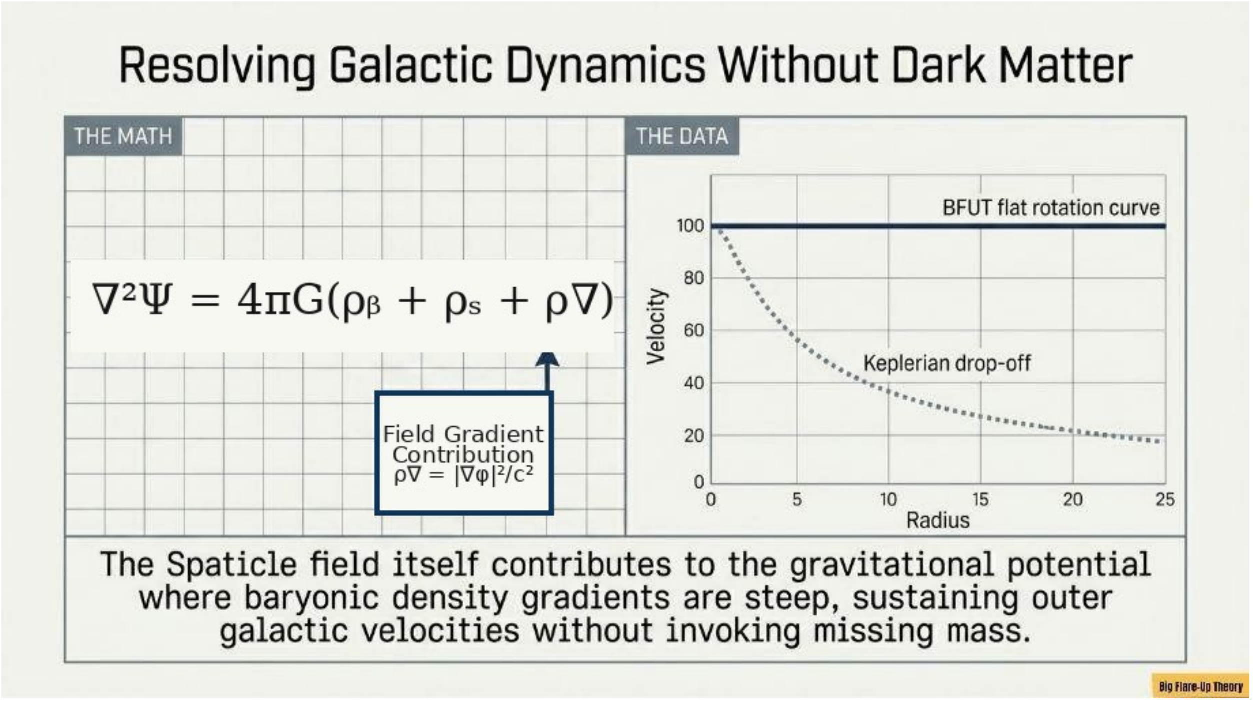

Figure 7. Galactic rotation dynamics: the organised, rotating Spaticle medium supplies the extra gravity that sustains flat rotation curves, described by the dark matter effects equation (DME).

5. The Emergence of the Strong Nuclear Force

5.1 The Structural Prerequisites Established in BFUT Paper 16

The strong nuclear force arises when the Spaticle field forms compact, internally structured condensations. Their internal organisation makes their mutual approach produce dynamics distinct from the diffuse deformation gradient of gravity.

BFUT Paper 16 established constructively that such condensations exist and can be derived from first principles within the Spaticle field framework. The paper built a free-energy functional:

where A/R^2 represents localisation or kinetic-like cost; BR^2 represents bulk displacement cost in the Spaticle substrate; CR represents boundary or gradient cost; and D/R represents internal circulation or confined-mode support. This functional exhibits a stable interior minimum at R_0 = 1.27348 model units with minimum free-energy E^* = 1.582 model units, confirmed as non-artifactual through robustness scans across 2D, 3D, and reduced 4D parameter spaces.

Paper 16 demonstrated that the first stable cooperative structure forms at n=3, where three co-rotating substrate units form the three-core at E=0.900 model units. A partition energy comparison at n=4 confirms the preferred arrangement: 4+0 = 6.10, 2+2 = 4.00, 3+1 = 1.40 in model energy units. The three-core then generates its own smaller counter-rotating electron through the 3+e mechanism, reaching E=0.896 model units. This 3+e preference persists across 97.56% of 1D scans, 95.95% of 2D scans, and 90.43% of 3D scans using the full five-term functional. The result is a structural bifurcation: a retained compact cooperative three-core (proton, effective charges +2/3, +2/3, −1/3, net charge +1) and a generated electron (charge −1).

It is these compact, internally structured three-core condensations, the protons established in Paper 16, that constitute the structural prerequisite for strong-force dynamics.

5.2 The Physical Mechanism of Strong Force Emergence

When two or more compact three-core protons are brought into close proximity, the Spaticle field between and within them becomes highly compressed. The internal substrate organisation of each condensation, self-stabilising in isolation as shown by Paper 16's interior minimum, interacts with the substrate configuration of its neighbour. At intermediate short distances, this inter-condensation coupling generates an extremely strong restoring force that binds the configurations together. At distances below the condensation radius R*, further compression carries a steep energy cost and produces the hard-core repulsion characteristic of the strong force. Strong attraction at intermediate distance and hard-core repulsion at very short distance follow from the energy landscape established by Paper 16's free-energy functional.

5.2A The Two-Condensation Energy Functional

The strong-force properties established in Sections 5.2 and 5.3 are represented by a two-condensation energy functional. For two proton condensations separated by distance d, the total energy is given below. The same functional applies to inter-proton separation, where d measures the distance between complete three-core condensations, and intra-condensation separation, where d measures the distance between one constituent quark-core and the remaining two-core structure. The confinement term describes the intra-condensation case.

E(total)(d) = 2 E(cond) + E(overlap)(d) + E(compression)(d) + E(reconfiguration)(d)

where E(cond) = 0.8958 model units is the single-condensation energy established in Paper 16 (fixed, independent of d), and the three interaction terms are:

E(overlap)(d) = -A(s) × exp(-d / L(rlx))

The first term represents the attractive overlap of the two substrate-deformation fields. Its amplitude A(s) inherits the condensation energy scale, and its decay length L(rlx) is the Spaticle relaxation length derived in Paper 18. The term dominates near the relaxation scale and vanishes as the separation becomes much larger than L(rlx).

E(compression)(d) = B(s) × $(r_p / d)^{12}$

The second term represents hard-core repulsion as the three-sphere geometries begin to overlap. The exponent 12 expresses the steep exclusion response at $d < r_p$, and B(s) carries the condensation energy scale. Paper 19 fixes the corresponding normalisation through the particle-sector energy and volume mapping.

$E(\text{reconfiguration})(d) = C_s \times d$

The third term represents confinement. Bernoulli co-rotation binds the three-core, and separation produces two restoring low-pressure contributions whose nearly constant force generates a linear potential. Evaluation at $\rho\text{cond} = E\_\text{unit}/(V_q\, c^2) = 2.135 \times 10^{18}$ kg/m³ gives C_s = Fconf = 0.574 GeV/fm. This equals 63.8% of the measured QCD string tension of 0.900 GeV/fm. Paper 19 Section 20.6 presents the complete calculation together with the short-separation behaviour.

The three regimes of E(total)(d) follow automatically from this single functional:

d >> L(rlx): E(overlap) -> 0, E(reconfiguration) ~ C_s d rises linearly. Energy increases with separation. Confinement.

d ~ L(rlx): E(overlap) dominates. Energy minimum at d* ~ L(rlx). Natural binding separation.

$d < r_p$: E(compression) dominates. Steep repulsion. Hard-core exclusion.

Attraction, hard-core repulsion, and confinement arise from this single energy landscape. A(s) and B(s) inherit the condensation scale and relaxation structure established in Papers 16, 18, and 19. C_s follows from the condensation energy density and the Bernoulli co-rotation mechanism derived in Paper 19 Section 20.6.

5.3 Three Distinctive Properties from Substrate Physics

Short range: The inter-condensation Spaticle coupling is effective only at distances comparable to the condensation radius R*. Beyond that distance, the local Spaticle field returns to its ambient configuration and the coupling falls to zero. This is not a separately postulated cutoff but a consequence of the finite size of the condensations established in Paper 16.

Extreme strength: At distances within R*, the compressed Spaticle configuration produces forces vastly larger than the large-scale deformation gradient. The reason is the density of internal Spaticle organisation: the compact three-core concentrates the substrate into a small volume, so small displacements produce enormous restoring forces.

Confinement: Separating two bound proton condensations stretches and distorts the inter-condensation Spaticle configuration. The required energy increases with separation until new first-unit excitations nucleate from the substrate through the process demonstrated in Paper 16. New quarks then form while the original bound configuration remains confined. The same substrate nucleation dynamics therefore produces confinement.

The short range, extreme strength, and confinement of the strong force follow from the finite size, high density, and internal organisation of the compact condensations derived in Paper 16.

5.4 Why the Strong Force Emerges Second

The strong force requires compact internally structured condensations as prerequisites, the three-core protons of Paper 16. Gravity requires only mass in a substrate. The strong force requires the full 3+e threshold to have been crossed. It therefore emerges necessarily after gravity but automatically and immediately once the Paper 16 threshold is reached.

6. The Emergence of Electromagnetism

6.1 Charge as Persistent Rotational Asymmetry of Internal Spaticle Configuration

Electromagnetism requires a further level of structural complexity beyond what gives rise to the strong force. It does not arise simply from the proximity of compact condensations. It requires condensations that carry a specific persistent asymmetry in their internal Spaticle field organisation, what standard physics names electric charge.

In the BFUT account, charge is not an independently postulated attribute that happens to attach to particles. It is a direct and necessary consequence of the structural event described in BFUT Paper 16: the 3+e threshold bifurcation. When four repeated quarks reorganise at the first stable threshold, three units form a compact cooperative core and the three-core generates a smaller counter-rotating electron (the 3+e state). These two products of the same event cannot be identical in their internal Spaticle configuration, because they are complementary results of the structural bifurcation: the three-core has organised its internal Spaticle substrate into a cooperative rotating mode, while the generated electron unit carries the opposite internal circulation.

The specific character of this internal asymmetry is rotational. The three-core retains a net internal Spaticle circulation, three units cooperating in a closed internal configuration, that is not present in the ambient field. The generated electron unit carries the opposite circulation. These are not identical copies of the original quark. They are structurally differentiated by their internal Spaticle flow direction. The three-core's net internal circulation constitutes positive charge. The generated electron unit's opposite circulation constitutes negative charge. These assignments are not arbitrary labels: they reflect a real physical asymmetry in the internal Spaticle configuration of each structure, inherited directly from the geometry of the bifurcation that produced them.

Charge emerges at the 3+e bifurcation. The Paper 16 threshold event produces the internal structural asymmetry of charge together with protons, electrons, hydrogen, and the prerequisites for the strong force. Charge, the strong force, electromagnetism, and ordinary hydrogen therefore emerge from the same threshold event in that structural order.

BFUT derives charge as the internal Spaticle-circulation asymmetry produced by the 3+e bifurcation.

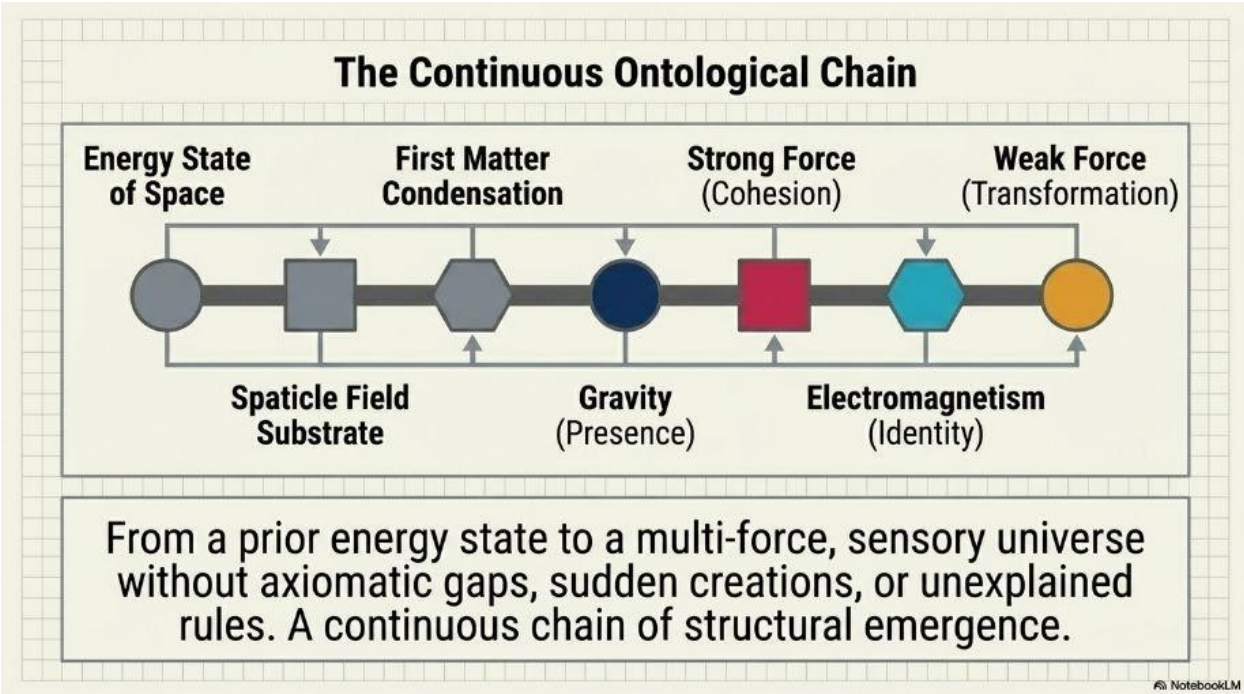

Figure 8. The continuous ontological chain: sequential emergence from a prior energy state through first matter condensation to the four fundamental forces, with no axiomatic gaps.

6.2 The Static Electromagnetic Field: How a Charged Condensation Deforms the Spaticle Substrate

A stationary charged condensation, a proton or electron as produced by Paper 16, sits within the Spaticle field with its persistent internal circulation asymmetry. This asymmetry does not merely affect the condensation's interior. It couples to the surrounding Spaticle field and produces a deformation in it that is qualitatively different from the compression-deformation gradient of gravity.

Gravitational deformation is isotropic: the Spaticle field is compressed and displaced symmetrically around a mass, and the resulting pressure gradient points radially inward toward the mass from all directions. The deformation produced by internal circulation asymmetry is not isotropic. The rotating internal Spaticle configuration of a charged condensation induces a directional circulation pattern in the surrounding field. The Spaticle field immediately adjacent to a proton tends to be drawn into alignment with the condensation's internal circulation. The field adjacent to an electron tends to be drawn into alignment with the opposite circulation.

This produces a directional pattern in the surrounding Spaticle field, what is described geometrically in standard physics as the electric field, that points outward from a proton and inward toward an electron. The spatial extent of this pattern depends on how far the internal circulation influence propagates through the substrate. Because the Spaticle field is continuous and space-filling, this influence propagates indefinitely, falling off with distance as the substrate restores its ambient configuration. The static electromagnetic field of a charged condensation is therefore the directional Spaticle field pattern produced by the internal circulation asymmetry of that condensation, propagating through the continuous substrate.

6.2A The BFUT Electromagnetic Field Equation

The directional substrate asymmetry field generated by a charged condensation can be expressed as a field equation. Let A^μ denote the directional substrate asymmetry four-field, the Spaticle-field analogue of the electromagnetic four-potential. Its spatial component is denoted A and its temporal component φ. The field equation is:

$$(1/c^2)\, \partial^2 A/\partial t^2 - \nabla^2 A + \beta A + \kappa_{EM}(A\cdot A)A = J(\mathrm{rot})$$

where the substrate parameters are fixed by the BFUT framework, while the quantitative source normalisation and charge coupling are established in the companion derivations:

J(rot) is the circulation source generated by the rotational asymmetry of the 3+e state. For a proton condensation, $J(\mathrm{rot}) > 0$; for an electron condensation, $J(\mathrm{rot}) < 0$; and for a neutral configuration, the contributions cancel so that $J(\mathrm{rot}) = 0$.

The restoration coefficient β depends on the excitation mode and is related to its effective rest mass through $\beta(\mathrm{mode}) = m^2(\mathrm{eff,mode})c^2/\hbar^2$. It characterises the restoring response of the directional excitation under consideration.

For the electromagnetic mode, the photon is massless and therefore $\beta(\mathrm{EM}) = 0$. The electromagnetic directional asymmetry propagates without a mass-induced attenuation term.

For the weak-interaction modes, the directional excitation is massive. The corresponding effective mass and its quantitative derivation are established in BFUT Papers 18 and 19. The resulting finite β(W) and β(Z) give the W and Z excitations their respective short propagation ranges. P17 therefore uses β as the common mode-dependent parameter that distinguishes the massless electromagnetic propagation regime from the massive weak-interaction regime, while the numerical values of the weak-sector masses are derived independently in the Paper 18-Paper 19 chain.

The distinction is essential: the absence of a bare mass term in the equilibrium Spaticle substrate does not prohibit effective masses of localised excitation modes. The former describes the background field; the latter describes the restoring energy of a particular excitation.

The electromagnetic limit is obtained by setting $\beta_{EM} = 0$ and retaining the linear directional field sector. With the spatial and temporal components A and φ of A^μ identified as the electromagnetic vector and scalar potentials, $E = -\nabla\varphi - \partial A/\partial t$, $B = \nabla \times A$, and imposing the Lorenz gauge condition $\nabla\cdot A + (1/c^2)\partial\varphi/\partial t = 0$. With these definitions, the source-free linear directional-field equation reduces to the standard electromagnetic wave equation for the potentials, $(1/c^2)\partial^2 A/\partial t^2 - \nabla^2 A = 0$, and similarly for φ. Taking the divergence and curl of the potential definitions gives $\nabla\cdot B = 0$, $\nabla\times E = -\partial B/\partial t$. With the sourced potential equations, the remaining two Maxwell equations follow: $\nabla\cdot E = \rho_e/\varepsilon_0$, $\nabla\times B = \mu_0 J_e + (1/c^2)\partial E/\partial t$. Thus the β_EM = 0 linear limit reproduces the Maxwell field equations when the directional substrate field is mapped to the electromagnetic four-potential. The detailed quantitative coupling and charge normalisation are established elsewhere in the BFUT programme.

For the massive weak-interaction modes, β(W) > 0 and β(Z) > 0, with their respective values determined by the derived W and Z effective masses. Each therefore has a finite restoration scale. The same substrate equation therefore contains a massless electromagnetic propagation regime and a massive weak-interaction regime.

The electromagnetic and weak interactions arise as distinct excitation regimes of the same substrate directional-asymmetry framework. Electromagnetism corresponds to the massless β(EM) = 0 mode, while the weak interaction corresponds to massive excitation modes with β(W) > 0 and β(Z) > 0. Paper 19 derives the weak-sector masses and electroweak parameters from the BFUT particle and field quantities.

6.3 Electromagnetic Propagation: The Time-Varying Polarised Spaticle Wave

A stationary charge produces a static, time-independent directional pattern in the surrounding Spaticle field. The new and distinctive physics of electromagnetism arises when the charge is in motion or acceleration.

When a charged condensation moves, its internal circulation asymmetry changes position within the Spaticle substrate. The directional field pattern it produces in the substrate must therefore change configuration continuously to match the new position of the condensation. These changes propagate outward through the substrate at the maximum propagation speed of the Spaticle medium. This maximum propagation speed is a fixed property of the substrate, determined by the relationship between its density, compressibility, and restoring force, and is what is measured as the speed of light, c.

When a charged condensation accelerates, changes its velocity, the change in the rate of reconfiguration of the surrounding directional pattern produces a qualitatively new type of substrate disturbance. The accelerating condensation generates a time-varying disturbance that is not merely a repositioning of the static field pattern but a propagating wave in the directionality of the Spaticle configuration itself. This propagating directional wave is the electromagnetic radiation field. Its quanta, photons, are quantised packets of this propagating Spaticle directionality wave, carrying a definite frequency, wavelength, polarisation, and propagation direction.

Several properties of electromagnetic radiation follow immediately from this substrate account. The propagation speed is fixed at c because it is determined by the Spaticle medium's physical properties and is independent of source or receiver motion. The wave is transverse because the internal circulation asymmetry of the source generates a rotational perturbation perpendicular to the propagation direction. Polarisation reflects the orientation of that internal circulation asymmetry at emission. The wave carries energy as a physical disturbance of the Spaticle substrate.

Electromagnetic radiation is a time-varying directional Spaticle-field perturbation produced by an accelerating charge asymmetry and propagated through the substrate at its maximum reorganisation speed c.

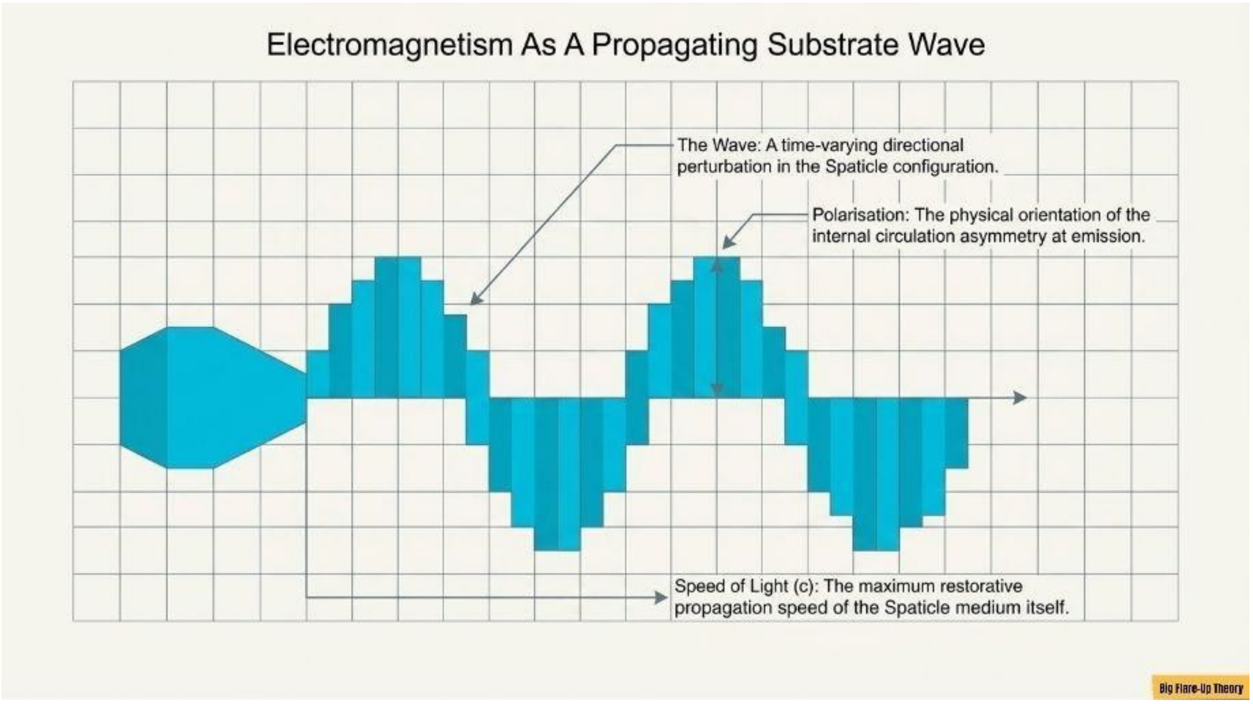

Figure 9. Electromagnetism as a propagating directional wave in the Spaticle-field configuration, with polarisation reflecting the source's internal circulation asymmetry.

6.4 Why Electromagnetism Can Be Attractive or Repulsive

The most distinctive feature of electromagnetism, absent in gravity, is its bidirectionality: like charges repel and opposite charges attract. This follows directly from the substrate account of charge as internal circulation asymmetry.

Consider two protons brought into proximity. Each carries the same internal circulation direction. Each produces a directional Spaticle field pattern aligned with that circulation. When these two identical patterns approach each other, the Spaticle field between them carries conflicting directional influences from both sources simultaneously. The substrate cannot simultaneously accommodate two opposing circulation orientations in the same region. The result is a high-energy configuration that the substrate resolves by pushing the two structures apart, electromagnetic repulsion.

Now consider a proton and an electron brought into proximity. These carry opposite internal circulation directions. Each produces a directional Spaticle field pattern aligned with its circulation. When these two opposite patterns approach each other, the Spaticle field between them finds a lower-energy configuration by allowing the two opposite circulation influences to partially cancel. The substrate settles into a configuration that draws the two structures toward each other, electromagnetic attraction.

This is why opposite charges attract and like charges repel. It is not a separately postulated law. It is a mechanical consequence of the substrate physics of circulation asymmetry: complementary asymmetries lower the field energy between them; identical asymmetries raise it.

Gravity, by contrast, is always attractive because gravitational deformation is always a compression of the same type: mass always compresses the substrate, and any second mass finds the equilibrium direction toward the first. There is no analogue of opposite internal circulations in gravitational deformation. This is why gravity cannot be repulsive within the BFUT framework.

6.5 Why Electromagnetism Can Be Shielded

Gravity cannot be shielded because every mass produces the same type of compression deformation, so gravitational contributions add. Electromagnetism can be shielded because opposite charge asymmetries can be paired. A proton and an electron in close proximity produce opposing directional Spaticle-field patterns that cancel at large distances, creating an electrically neutral object with effectively zero net directional influence on distant structures.

This explains the existence of electrically neutral atoms and why neutral objects do not exert electromagnetic forces at large distances. Within ordinary hydrogen, the first atom established in Paper 16, consisting of one proton core and one electron branch, the two opposite circulation asymmetries are associated with the same system, and their net directional influence on the surrounding Spaticle field at large distances is greatly reduced. The atom is gravitationally active but electromagnetically neutral at large range.

6.6 The Speed of Light as the Maximum Propagation Speed of the Spaticle Medium

One of the most important consequences of the BFUT electromagnetic account is the physical explanation of why there is a maximum propagation speed in the universe, and why it is the same for all electromagnetic disturbances regardless of source or observer motion.

In the standard account, the constancy of the speed of light is a postulate, a brute fact embedded in special relativity. In the BFUT account, it is a derived property. The Spaticle field is a physical medium with definite density and compressibility. Every physical medium has a maximum propagation speed for disturbances, the speed at which perturbations can travel through the medium without the medium's internal restoring forces being exceeded. For the Spaticle field, this maximum propagation speed is c.

The speed of light is constant for all observers because the Spaticle field is the same medium everywhere and for every observer. The medium has no detectable preferred rest frame of the classical-aether type. Its local physical laws preserve Lorentz covariance as established in BFUT Paper 1, and its propagation speed is a physical constant of the medium. The Michelson-Morley result excludes a classical aether with detectable preferred drift and is consistent with a Lorentz-compatible substrate whose local laws preserve relativistic covariance. [1][11]

6.7 Information Richness: Why Electromagnetism Is the Primary Carrier of Structured Information

The gravitational deformation gradient carries one piece of information: the direction and magnitude of the mass distribution deforming the local substrate. It does not carry frequency, polarisation, phase, or modulation. It simply reports the presence and distribution of mass.

The electromagnetic propagating wave carries multiple independent physical properties simultaneously: frequency (determined by the rate of the source's oscillation), polarisation (determined by the orientation of the internal circulation asymmetry of the source), amplitude (determined by the magnitude of the charge and its acceleration), and phase (determined by the timing of emission). Each of these properties is independently variable and independently detectable by a receiving system.

This multi-dimensional information structure arises because the electromagnetic disturbance is produced by the directional Spaticle field pattern of a charged condensation, a pattern with intrinsic directionality, rotation, and time structure, not by the isotropic compression-deformation of a gravitational mass. The richer the source structure, the richer the information that can be encoded in the resulting Spaticle disturbance. Electromagnetism is therefore the primary long-range channel for transmitting specific identity information: through it, a receiving system can determine not merely that something is present but what it is, how it is configured, and how it is moving.

6.8 Why Electromagnetism Emerges Third

The structural prerequisite for electromagnetism is charge: the persistent internal circulation asymmetry produced by the Paper 16 3+e bifurcation. The bifurcation follows the formation of the compact three-core and produces the charged proton and electron configurations. Both structures arise from the Spaticle field and the first quark established in Papers 14 and 16. Electromagnetism therefore emerges third as an automatic consequence of the threshold event that produces a proton and an electron. Once those structures exist, electromagnetic interaction is immediate and unavoidable.

This section derives the physical origin of charge, electromagnetic propagation, bidirectionality, shieldability, finite propagation speed, and information richness from Spaticle-field dynamics.

7. The Emergence of the Weak Nuclear Force

7.1 The Structural Prerequisite: Transformation-Capable Internal Topology

The weak nuclear force is the most structurally demanding of the four and requires careful distinction from the other three. Gravity, the strong force, and electromagnetism are all, in their primary character, forces of attraction or repulsion between existing structures. The weak force is categorically different: it is not primarily a force between structures but an interaction that transforms one type of internal Spaticle condensation into another. A neutron-class structure converts to a proton through internal quark reconfiguration. One quark flavour converts to another. These are genuine changes in the internal Spaticle topology of a compact condensation.

The weak interaction requires compact charged condensations whose internal Spaticle topology can be reconfigured. Their organisation supports transitions between stable internal configurations when the required energy threshold is reached.

In terms of the BFUT Paper 16 framework, this requires the 3+e bifurcation product (the proton three-core with effective charges +2/3, +2/3, −1/3), but a bound multi-nucleon system in which one component of the three-core can change its effective charge assignment, converting the system from one type to another. This is a higher-order structural requirement: it requires that multiple protons be bound together by the strong force (Section 5) and that the energy conditions within that bound system be capable of driving an internal Spaticle reconfiguration.

7.2 The Mediating Disturbance: Massive Spaticle Field Excitations

In the BFUT account, the mediating particles of the weak force, the W and Z bosons, are understood as temporary, massive, highly localised excitations of the Spaticle field that carry the internal-reconfiguration information from one part of the bound system to another.

Why are these mediating excitations massive, in contrast to the photon which is massless? The answer follows from the substrate account. A photon is a propagating directional wave in the Spaticle field, a perturbation in the field's circulation pattern that travels freely through the ambient substrate at speed c, carrying no rest energy of its own. It can propagate indefinitely because it is a wave in the field's pre-existing directional structure, which costs nothing to maintain in the unperturbed field.

A W or Z boson, in contrast, is not a propagating wave in a pre-existing directional structure. It is a temporary excitation that carries the information required to transform one internal Spaticle topology into another. To transmit this information, the excitation must carry within itself the energy cost of the internal reconfiguration, the energy difference between the initial and final internal Spaticle configurations of the condensation being transformed. This energy cost is large compared to the energy carried by a photon because internal Spaticle topology reconfiguration requires reorganising the compact, high-density internal structure of a three-core condensation. The mediating excitation is therefore massive: it carries a definite rest energy corresponding to the substrate reorganisation cost.

The W and Z excitations carry the substrate-reorganisation energy associated with an internal topology change. Their masses produce finite restoration coefficients β(W) and β(Z) and corresponding propagation lengths $L(W) = \hbar/(m(W)\,c)$ and $L(Z) = \hbar/(m(Z)\,c)$. These short restoration lengths localise the interaction and produce the observed short range of the weak force.

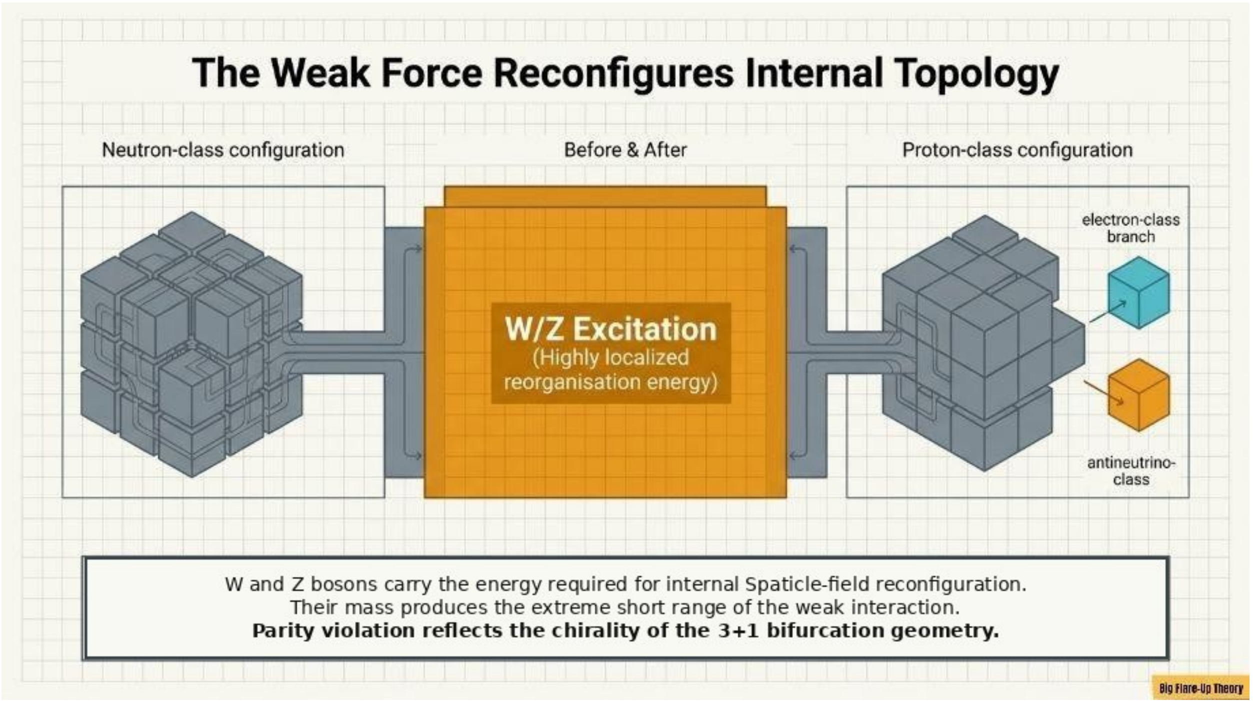

Figure 10. The weak force reconfigures internal topology between neutron-class and proton-class configurations through a highly localised W or Z excitation.

> BFUT derivation: W/Z mass ↔ internal Spaticle reconfiguration energy cost. Weak force range ↔ propagation distance of a massive localised Spaticle excitation before energy absorption. Both properties follow from the same substrate physics, not from two separately postulated facts.

7.3 The Mechanism of Internal Topology Reconfiguration

How exactly does the weak interaction transform one type of condensation into another? In the BFUT substrate account, this proceeds in three stages.

First, the conditions within a bound multi-nucleon system can reach the internal reconfiguration threshold required by the BFUT substrate account. In a nucleus, the strong-force binding energy and the internal energy of the bound system determine whether the relevant transition can occur. This internal reconfiguration threshold is associated with the W/Z excitation mode, but it is distinct from the external energy required to produce an on-shell W or Z boson in a particle collider, of order 80-90 GeV. Low-energy weak transformations such as beta decay and electron capture proceed through virtual, off-shell W/Z exchange and do not require on-shell W or Z production.

Second, the reconfiguration is mediated by a W or Z excitation of the substrate. In low-energy weak transformations this excitation is virtual; when on-shell production is kinematically allowed, a real W or Z boson can be produced. In the BFUT interpretation, the excitation carries the internal reconfiguration associated with the transition between the initial and final states.

Third, the massive excitation is absorbed by the target component of the system, another part of the condensation or a neighbouring condensation, and deposits its reorganisation energy, causing the target's internal Spaticle topology to reconfigure to the new stable state. A neutron-class configuration, for example, reorganises one of its effective charge units from −1/3 to +2/3, producing a proton plus an emitted electron branch and an antineutrino-class unit.

The antineutrino-class unit deserves separate comment within the BFUT framework. In the substrate account, it represents the residual Spaticle field disturbance produced by the reconfiguration event, a very weakly coupled propagating excitation that carries the angular momentum balance and lepton number balance of the reaction, but which interacts with the substrate only through the weak channel and gravity. Its extremely weak coupling to the Spaticle field explains its near-masslessness and its ability to propagate vast distances through the substrate without interaction.

7.4 Parity Violation: An Asymmetry in the Direction of Internal Spaticle Reconfiguration

One of the most striking properties of the weak interaction is its violation of parity symmetry. The charged-current weak interaction is chiral, coupling to left-handed fermions and right-handed antifermions. This was established experimentally in the twentieth century, including the Wu et al. (1957) experiment [16]. The Standard Model describes this behaviour through its chiral weak-current structure. The BFUT account in Section 7.4 proposes a physical substrate interpretation of that parity violation.

7.4A The Dominance Principle

The substrate field intensity of each body has two contributions: rest-mass substrate deformation and rotational energy. Their combined field intensity determines which structure dominates. Under normal conditions, the three-core's rest-mass deformation exceeds the electron unit's rotational contribution. The dominant co-rotating three-core therefore stresses the counter-rotating electron unit, and weak interaction reconfigures that stressed unit while preserving the stable three-core.

7.4B The Chirality of the Stressed Unit

The three-sphere packing geometry of Paper 16 Section 10 mechanically imparts counter-rotation to the generated electron unit. Interstitial substrate passing between two co-rotating surfaces of the same handedness acquires the opposite rotation. Generation proceeds outward along the same interstitial axis around which the three-core rotates. The circulation vector and generation direction are therefore antiparallel by construction:

$$\chi = \mathrm{sign}(\Omega_e \cdot \hat{p}) = \mathrm{sign}(-\Omega_{core} \cdot \hat{p}) = -1$$

The P19 mixing quantity is derived only after the independent W and Z resonance masses: $\sin^2\theta\_W\_vss = 1 - (m\_W\_vss/m\_Z\_vss)^2 = 1 - 256^2/(9\pi^8) = 0.23257$.

7.4C Hydrogen as the Reference State and the Complexity Hierarchy

Ground-state hydrogen represents the lowest weak-activity configuration in the matter hierarchy. The electron's counter-rotation is tuned to its natural orbital radius and angular velocity, producing a substrate field that closely cancels the three-core's co-rotating field in the external region. The substrate stress on the electron unit is at its minimum. The weak interaction probability is minimised - not because weak interactions are forbidden but because the circulation imbalance driving topology reconfiguration is minimised.

As protons, neutrons, and electrons are added, the number of interacting circulation structures increases. Exact circulation cancellation across all pairs simultaneously becomes progressively harder to maintain. The result is a hierarchy of increasing weak interaction activity: ground-state hydrogen at minimum, heavier atoms with multiple competing circulation structures, large unstable nuclei with significant residual imbalance and open β decay channels, and extreme environments where compression forces electrons to small orbital radii and electron capture dominates. Weak interactions are a response to accumulated circulation imbalance in increasingly complex matter structures. This is why weak interaction rates increase with nuclear complexity.

7.4D Dominance Inversion and Neutron Formation

Under extreme compression the electron's rotational energy density at close range can exceed the three-core's rest-mass substrate deformation. Dominance inverts. The three-core becomes the stressed body. Its internal topology reconfigures - this is electron capture and neutron formation. The neutron-proton-electron mass-energy difference $(m_n - m_p - m_e)c^2 \approx 0.782$ MeV, relevant to neutron beta decay, is interpreted within BFUT as the physical manifestation of the dominance-inversion threshold. This is distinct from nuclear electron-capture thresholds, which are nucleus-dependent. Its derivation from ρ_s, r_p, and μ is given in the companion programme. Neutron star formation is bulk dominance inversion: simultaneous inversion across every proton-electron pair in a collapsing stellar mass.

7.4E Cross-Scale Unification

The same dominance principle operates at cosmic scales. Gravitational sorting, established in BFUT Paper 9, produces preferred co-rotation directions at every scale. Counter-rotating bodies within co-rotating systems are stressed by the dominant body and are the preferred sites of structural reconfiguration. Neptune's retrograde moon Triton is being slowly destroyed by tidal forces from Neptune - the dominant co-rotating body stresses the counter-rotating body, not the reverse. The weak force, electron capture, and retrograde orbital decay are three expressions of the same physical principle: counter-rotating structures in a substrate organised by co-rotation are stressed by the dominant co-rotating body and undergo reconfiguration when the stress exceeds their topological stability threshold.

The P19 mixing quantity is derived only after the independent W and Z resonance masses: $\sin^2\theta\_W\_vss = 1 - (m\_W\_vss/m\_Z\_vss)^2 = 1 - 256^2/(9\pi^8) = 0.23257$.

An interactive simulation of the strong force confinement mechanism, electromagnetic field emergence, parity violation, and weak force dominance inversion at the 0.782 MeV threshold is available in the BFUT companion simulations code deposit (DOI: 10.5281/zenodo.20554084). [10]

7.5 Why the Weak Force Emerges Last

The BFUT account places the weak force after the earlier structural stages in its proposed complexity sequence. It requires the Spaticle field substrate (Paper 14), the first quark condensations (Paper 16), the 3+e threshold producing proton and electrons (Paper 16), gravitational binding of matter into concentrated regions (Section 3), strong-force binding of protons into multi-nucleon systems (Section 5), and an internal reconfiguration condition associated with the W/Z excitation modes. The latter is distinct from the on-shell production threshold for real W or Z bosons.

The weak force is therefore not absent at early stages of BFUT cosmological history. It is operative wherever and whenever its structural prerequisites are met, within stellar interiors, within supernovae, within any high-energy collision event. But because its prerequisites are the most demanding of the four forces, it is the last to become operative as the complexity chain progresses from the initial Spaticle field through condensation, hydrogen formation, gravitational accumulation, stellar ignition, and nuclear binding.

This sequential emergence, gravity first, then strong force, then electromagnetism, then weak force, is not arbitrary. It maps exactly onto the hierarchy of structural complexity required for participation in each force. Gravity requires only mass. The strong force requires compact organised condensations. Electromagnetism requires charged condensations with internal circulation asymmetry. The weak force requires complex internal condensations whose topology can undergo reconfiguration under the relevant energy conditions. The complexity hierarchy of the forces is the complexity hierarchy of the Spaticle field substrate.

Sections 6 and 7 derive the physical mechanisms of electromagnetism and the weak force from Spaticle-field dynamics, including charge, propagation, mediation, range, and parity violation.

8. Forces as Fundamental Sensing Channels: A Unified Philosophical Framework

This section establishes the correspondence between the four fundamental forces and fundamental sensing modes. This correspondence is grounded in the physical character of each force as established in Sections 3 through 7. The full scientific development of this framework, including a formal definition of sensing, the Hierarchical Channel Accessibility Law, the Structural Inclusion Principle, five falsifiable predictions, and the Consciousness Index, is presented in BFUT Paper 20 (https://doi.org/10.5281/zenodo.19992457). The present section provides the physical and conceptual foundation on which Paper 20 builds. Two levels are developed in sequence: the foundational four-force layer, which is Lagrangian-derived and physically necessary; and the emergent five-channel layer, which arises as matter organises into increasingly complex configurations. Together, they form one continuous framework across different scales of structural complexity. [8]

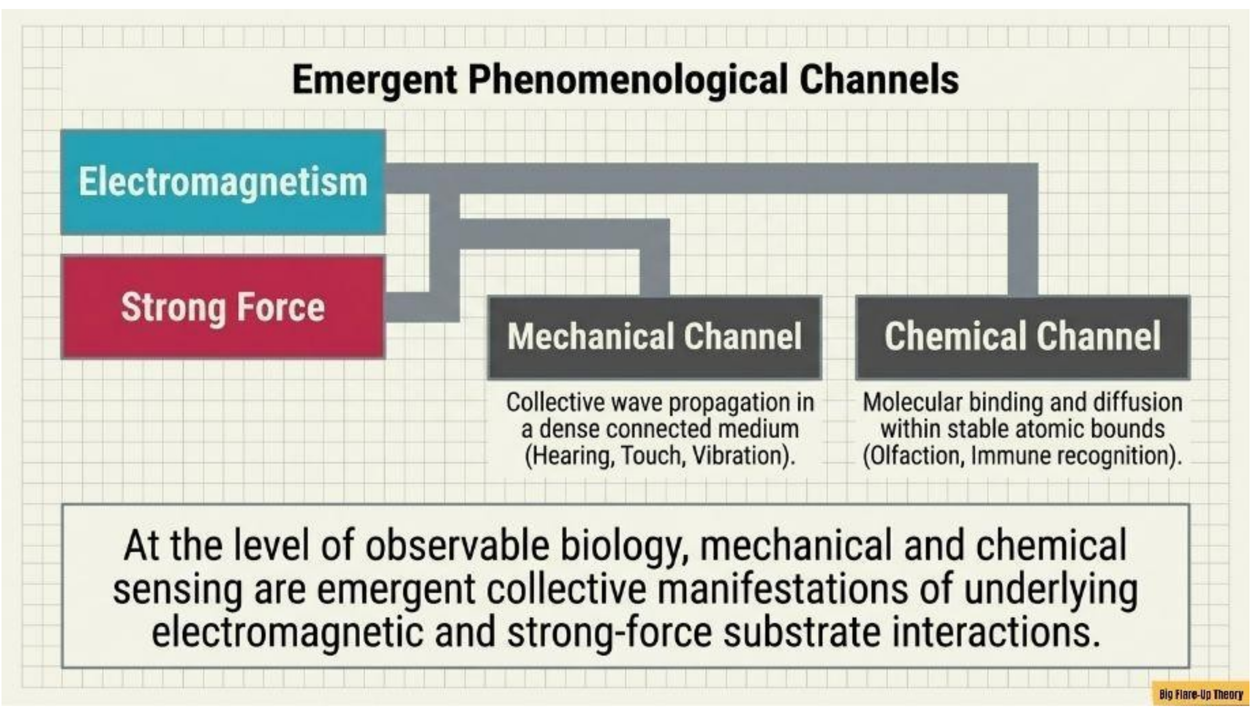

Figure 11. Forces and sensing channels emerge sequentially from the Spaticle field substrate as an interconnected taxonomy of electromagnetic, strong, mechanical, and chemical channels.

8.1 The Central Proposition: Interaction as Sensing

All physical interaction occurs through signal generation and signal coupling. A system cannot change without producing a physically real state transition, and that transition either propagates or remains confined depending on boundary conditions and coupling constraints. Signals are physically real, observer-independent events. This anchors interaction in structure, not description.

Every physical system, from a subatomic condensation to a galaxy receives information about the state of other systems through interaction channels. There is no other way for a physical system to receive information about its environment. Sensing, in this interpretation, is not a late-arriving biological innovation. It is a structural consequence of participation in physical interaction channels. Biological sensing systems are specialised implementations of universal physical detection modes that operate at every level of complexity from the simplest particle interaction upward.

This section develops this correspondence at two levels. The first is the foundational level: the four fundamental forces established in Sections 3 through 7, each derived from the Spaticle field Lagrangian, each constituting a physically necessary and irreducible sensing channel. The second is the emergent level: five phenomenological channels that arise as matter organises into denser and more complex configurations, providing the complete basis for observable sensing across all physical and biological systems. The two levels express the same framework at different scales of structural complexity. [4]

8.2 Gravity as the Sense of Presence

Gravity provides the universal channel through which a system responds to mass distribution and position. At biological scales, this channel contributes to proprioceptive and vestibular orientation.

8.3 Strong Force as the Sense of Binding

The strong force reports binding state and structural cohesion within composite nuclear structures. Its emergent particle channel appears through discrete transfer, collision, and decay events and supports structural-integrity sensing at larger scales.

8.4 Electromagnetism as the Sense of Identity State and Contact

Electromagnetism carries identity, configuration, and distant-state information through long-range field propagation. Its chemical manifestation carries molecular identity, concentration, and structure through binding and diffusion. Together with strong-force cohesion, its mechanical manifestation carries contact, deformation, vibration, and pressure through material media.

8.5 Weak Force as the Sense of Transformation

The weak force carries information about internal state and transformation thresholds through localised changes of particle topology. At biological scales, internal transformation supports interoception, metabolic sensing, and immune activation.

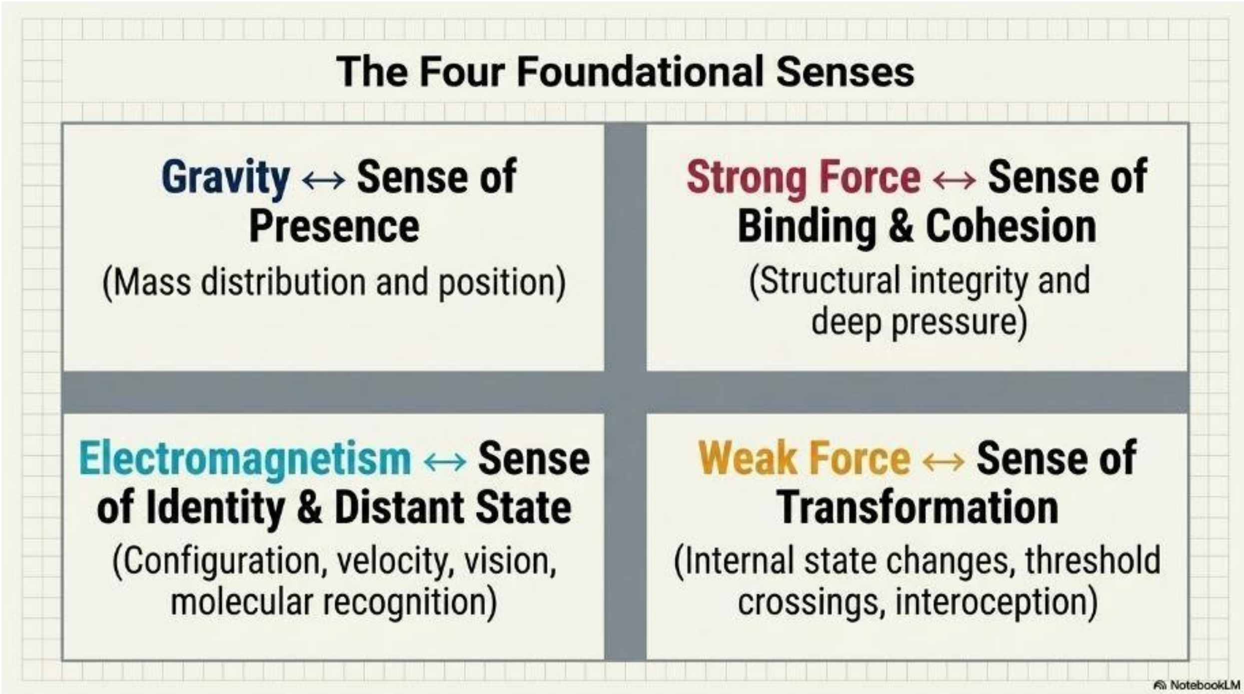

Figure 12. The four fundamental forces correspond to four foundational modes of sensing: presence, binding and cohesion, identity and distant state, and transformation.

8.6 Internal Versus External Sensing

The same channels operate internally and externally. External sensing involves signals arriving from other systems. Internal sensing monitors the system's own state. The mechanism is identical in both cases; system boundaries define the distinction.

Gravitational sensing is inherently external: it responds to mass distributions outside the sensing system. Electromagnetic sensing is primarily external at the photon-detection level and also operates internally through charge-distribution monitoring, membrane potential, and neural signalling. Strong-force sensing is primarily internal to composite nuclear structures and monitors whether bound components are correctly held. Weak-force sensing is maximally internal and mediates internal state transformation. Mechanical sensing operates externally through sound and environmental vibration and internally through structural stress and deformation. Chemical sensing operates externally through olfaction and taste and internally through metabolic state, hormonal concentration, and immune signals.

At increasing levels of structural complexity, systems develop the capacity to use each channel both internally and externally. This dual use of the same fundamental channel for both external and internal sensing is a general feature of all complex physical systems and reflects the underlying unity of the signal-channel structure across all scales of complexity.

8.7 Memory, Integration, and the Threshold of Sensing

Signals are transient. Structured behaviour requires persistence. Memory retains state through stable or metastable configurations, allowing comparison across time and enabling prediction. A system possesses a sense when it can reliably detect, transform, and respond to signals in a repeatable manner. This marks the transition from passive interaction to structured sensing.

Systems operate across multiple channels simultaneously. Integration occurs because all signals act on the same physical substrate. Combined state transitions encode multi-channel information. Higher complexity arises from integrated response. The most complex biological sensing systems, including the mammalian nervous, immune, and endocrine systems, integrate signals across all five phenomenological channels with memory, prediction, and controlled response operating across multiple timescales.

Signals are ubiquitous. Interaction occurs only when coupling conditions are satisfied: energy compatibility, structural alignment, and dynamic accessibility. Selectivity follows directly from physical constraints. Systems respond only to compatible signals. This selectivity, combined with memory and multi-channel integration, is what produces the richness and specificity of biological sensing from the same underlying physical channels that operate in every interaction at every scale.

8.8 The Unified Interaction Loop

All interaction at every level, foundational or emergent, physical or biological, follows a single invariant loop: a system undergoes a state change; the change generates a signal; the signal propagates or remains local depending on the channel; another system couples if conditions permit; the receiving system undergoes a state change. This loop is invariant across all five channels and all scales of complexity. It applies equally to a gravitational deformation gradient propagating through the Spaticle field and to a neurotransmitter molecule diffusing across a synaptic cleft.

The two-level framework, comprising four foundational forces and five emergent channels, maps the same interaction loop at different levels of structural organisation. At the substrate level, the loop runs through the Spaticle field and its condensed structures. At the phenomenological level, it runs through the collective properties of matter assemblies, molecular identities, and biological sensing organs. Increasing structural complexity expands the information that participating systems can encode, transmit, and detect. [4]

The Substrate Complexity Matrix

Force	Structural Prerequisite	Substrate Mechanism	Action
Gravity	Mass	Isotropic deformation & pressure gradient	Sense of Presence
Strong	Compact 3-cores	Inter-condensation substrate compression	Sense of Cohesion
Electromagnetism	Charge Asymmetry	Time-varying polarised waves	Sense of Identity
Weak	Multi-nucleon bounds	Massive localised topological excitation	Sense of Transformation

Big Flare-Up Theory

Figure 13. Substrate complexity matrix linking each fundamental force to its structural prerequisite, substrate mechanism, and corresponding sensing action.

The two-level sensing framework identifies the physical mechanisms of the four fundamental forces and their emergent collective manifestations as the mechanisms that constitute the sensing channels of biological systems at the required structural complexity. The correspondence is structural across scales, and phenomenological experience occupies a further level of organisation within this framework.

9. Supporting Literature and Converging Evidence

The framework developed in this paper intersects with several bodies of established scientific work, each of which supports one or more aspects of the substrate-force-sense account.

Einstein's field equations describe a spacetime fabric that dynamically responds to mass-energy. The BFUT Spaticle-field identification supplies a physical matter substrate corresponding to that geometric description. [4][12]

BFUT establishes galactic dynamics without a dark-matter particle through the cosmological and dynamical arguments of Paper 1, the rotation-induced field structuring of Paper 6, the large-scale rotational behaviour analysed in Paper 9, and the quantitative modified field equations of Paper 18. [1][2][3][7]

The sequential emergence of forces with decreasing temperature and increasing structural complexity is a feature of Standard Model symmetry breaking. The BFUT account connects this sequence to the physical organisation of the Spaticle substrate and derives why four interaction modes arise. [13][14]

The experimental confirmation of parity violation in weak interactions (Wu et al., 1957) [16] is described in the Standard Model through its chiral weak-current structure. The BFUT account in

Section 7.4 proposes a physically motivated substrate interpretation grounded in the chirality of the Paper 16 3+e bifurcation.

Wheeler's "It from Bit" proposal treats physical reality as fundamentally informational. The present framework grounds information and signal channels in the physical Spaticle substrate. [15]

The correspondence between biological senses and physical signal types has been discussed phenomenologically in the literature (von Uexküll, 1909; Gibson, 1979). BFUT proposes a substrate-level account linking these signal types to the physical interaction channels developed in this paper.

10. Relationship to Prevailing Models

BFUT connects its physical substrate account to the established mathematical and empirical strengths of prevailing models.

The Standard Model of particle physics provides exceptionally precise predictions, including the electron anomalous magnetic moment and the properties of the W and Z bosons and the Higgs boson. BFUT supplies the physical substrate foundation from which the forces' existence and sequential emergence follow. The Standard Model supplies the precision mathematics describing the behaviour of those forces.

Grand unified theories and string-theoretic programmes address the mathematical unification of forces at high energy. BFUT establishes the physical matter substrate that supports the interactions and generates their sequential emergence. These accounts address connected levels of force unification.

BFUT establishes galactic dynamics without a dark-matter particle through Paper 1's cosmological and dynamical arguments, Paper 6's rotation-induced field structuring, Paper 9's large-scale rotational analysis, and Paper 18's quantitative modified gravitational equations. [1][2][3][7]

The P19 mixing quantity is derived only after the independent W and Z resonance masses: $\sin^2\theta\_W\_vss = 1 - (m\_W\_vss/m\_Z\_vss)^2 = 1 - 256^2/(9\pi^8) = 0.23257$.

Parity violation in the weak force has been experimentally confirmed (Wu et al., 1957) and described within the Standard Model through the V−A (vector minus axial-vector) structure of weak currents, but has not been given a physical substrate explanation. The BFUT account in Section 7.4 provides a physically motivated substrate interpretation. The degree of parity violation from Spaticle field parameters is derived in BFUT Paper 19. [9][16]

11. Physical Implications

11.1 Quantitative Force Emergence from Spaticle Field Parameters

The sequential emergence of all four forces is derived from Spaticle-field physics. Paper 16 provides the quantitative strong-force foundation, and Paper 18 provides the quantitative gravity foundation. The coefficients A, B, C, and D are derived from the three-sphere condensation geometry in Paper 16 Appendix C: $A = 1/2$, $B = 0.56308$, $C = -1/3$, and $D = 1$. Paper 19 derives the strong coupling constant and fine-structure constant from these coefficients and the Spaticle-field directional polarisability.

11.2 Parity Violation and the Chirality of the Bifurcation

The handedness of the original 3+e bifurcation is determined by the chirality of the Spaticle substrate at the condensation threshold. Left-handed dominance in weak interactions follows from the asymmetric circulation geometry of the 3+e topology established in P16.

11.3 Sensing Framework and Astrobiology

The force-sense correspondence of Section 8 reframes the search for life as the detection of coherent and persistent signal integration across multiple channels. Astrobiological searches can therefore identify complex signal-integrating Spaticle-field condensation systems through their integrated physical responses.

12. Connection to BFUT Gravitation and Sensing Results

The field-theoretic origin of gravity developed here connects the Spaticle action, its stress-energy contribution, the covariant gravitational field equation, the weak-field source structure, and the DME relation used across the 175-galaxy SPARC analysis.

BFUT Paper 18 presents the observable gravitational dynamics, parameter closure, galaxy-by-galaxy rotation-curve comparison, and extensions to galaxy clusters and additional datasets. [7]

The force-emergence results connect directly to Paper 18's gravitational dynamics and Paper 20's scientific framework for sensing, capability, consciousness, and evolution. [7][8]

13. Conclusion

This paper has established six principal results within the BFUT cosmological framework.

First, gravity is the inbuilt mechanical consequence of the Spaticle field's response to mass-induced deformation. The BFUT modified gravitational field equations, derived from the covariant field action, reproduce galaxy rotation behaviour without a dark-matter particle. Across 175 SPARC galaxies, the results give 92.0% shape agreement, 98.8% flat-curve classification, and a median outer relative residual of 0.096. [7]

Second, the strong nuclear force emerges directly from the compact three-core protons established in BFUT Paper 16, with short-range, extreme strength, and confinement all following from Paper 16's energy landscape without additional postulates.

Third, within the BFUT account, electromagnetism emerges from Spaticle-field substrate physics: charge is the persistent internal circulation asymmetry produced by the Paper 16 3+e bifurcation; electromagnetic propagation is the time-varying polarised Spaticle wave produced by an accelerating charge asymmetry; bidirectionality follows from complementary versus identical circulation interactions; shieldability follows from the cancellation of opposite asymmetries; the speed of light is the maximum propagation speed of the Spaticle medium; and information richness follows from the multi-dimensional character of the directional Spaticle wave.

Fourth, within the BFUT account, the weak nuclear force emerges from Spaticle-field substrate physics: transformation-capable internal topology is the structural prerequisite; the mass of the W and Z mediators corresponds to the internal Spaticle reconfiguration energy cost; the short-range of the weak force follows from the rapid energy dissipation of massive Spaticle excitations; and parity violation is interpreted as a consequence of the chirality of the Paper 16 3+e bifurcation geometry.

Fifth, each of the four fundamental forces corresponds to a fundamental sensing channel, developed into a complete scientific framework in BFUT Paper 20 (https://doi.org/10.5281/zenodo.19992457), which establishes the formal sensing definition, Hierarchical Channel Accessibility Law, Structural Inclusion Principle, five falsifiable predictions, and the Consciousness Index. Gravity is the sense of presence. The strong force is the sense of binding. Electromagnetism is the sense of identity and distant state. The weak force is the sense of transformation.

Sixth_vss establishes a continuous ontological chain from the prior energy state of infinite space through the Spaticle field, the first quark condensations and primordial hydrogen, the emergence of all four fundamental forces, and the resulting gravitational dynamics. This continuity-of-existence framework is physically connected across the BFUT programme and supported by its particle and astrophysical calculations.

References

BFUT Programme Bibliography

[1] [P1] Sharma, V.S. (2026). Gravitational Sorting as an Alternative Mechanism for the Hubble Relationship. Zenodo. https://doi.org/10.5281/zenodo.19226423

[2] [P6] Sharma, V.S. (2026). Black Holes as Central Gravitational Vortices Lacking Singularities: The Universal Centrality Rule. Zenodo. https://doi.org/10.5281/zenodo.19300874

[3] [P9] Sharma, V.S. (2026). Cosmic Rotation Across Scales, Emergent Orbital Hierarchy, and the Large-Scale Challenge to Metric Expansion. Zenodo. https://doi.org/10.5281/zenodo.19341549

[4] [P14] Sharma, V.S. (2026). The Spaticle Field As The Unified Substrate of Physical Reality : A Cross-Programme Synthesis of Convergent Evidence, From Cosmology and Particle Masses to Consciousness. Zenodo. https://doi.org/10.5281/zenodo.19394064

[5] [P15] Sharma, V.S. (2026). What Existed Before the Spacetime Fabric? The Origin of Space, Time, and the Physical Substrate of Reality in an Infinite Universe. Zenodo. https://doi.org/10.5281/zenodo.19811691

[6] [P16] Sharma, V.S. (2026). The Origin of Matter, Antimatter, and Fundamental Forces: How Protons, Electrons, and Hydrogen Formed. Zenodo. https://doi.org/10.5281/zenodo.19908215

[7] Sharma, V.S. (2026). Beyond General Relativity: A Unified Gravitation Equation Across Quantum, Classical, Galactic, and Rapid-Transition Regimes. BFUT P18. Zenodo. https://doi.org/10.5281/zenodo.20145506

[8] [P20] Sharma, V.S. (2026). From Matter and Fundamental Forces to Consciousness: A Unified Framework of Sensing Channels, Control, and Evolution. Zenodo. https://doi.org/10.5281/zenodo.19992457

[9] [P19] Sharma, V.S. (2026). Unification of Particle Physics: Deriving Fine Structure and Coupling Constants, W, Z, and Higgs Boson Masses, Redefining and Unifying Gravity and Time. BFUT P19. Zenodo. https://doi.org/10.5281/zenodo.20145567

[10] [Sim] Sharma, V.S. (2026). The Big Flare-Up Theory: Companion Simulations: Substrate Physics Visualised Across Particle, Quantum, and Cosmological Scales - Papers P16 to P26. Zenodo. https://doi.org/10.5281/zenodo.20554084

Selected External Literature

[11] Michelson, A.A., & Morley, E.W. (1887). On the relative motion of the Earth and the luminiferous ether. American Journal of Science, 34(203), 333-345.

[12] Einstein, A. (1915). Die Feldgleichungen der Gravitation. Sitzungsberichte der Preußischen Akademie der Wissenschaften.

[13] Salam, A. (1968). Weak and Electromagnetic Interactions. In: Svartholm, N. (ed.), Elementary Particle Theory. Almqvist & Wiksell.

[14] Weinberg, S. (1967). A model of leptons. Physical Review Letters, 19(21), 1264-1266.

[15] Wheeler, J.A. (1990). Information, Physics, Quantum: The Search for Links. In: Zurek, W.H. (ed.), Complexity, Entropy, and the Physics of Information. Addison-Wesley.

[16] Wu, C.S. et al. (1957). Experimental test of parity conservation in β decay. Physical Review, 105(4), 1413-1415.