

Spin-Impulse of Elementary Particles' and Force Fields' Topology

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Synthesis

The concept and formalism of a unified material field are proposed here. Its special solutions present quantum forms of gravity, electromagnetism, of strong and weak interactions, as well as its entanglement. Principles are given for the formal estimation of the electron-positron mass, as well as its spin, and the fine-structure constant in the form of integer ratios. In cosmology, quantum solutions to the problems of singularity, baryon asymmetry, and the origin of “dark” phenomena are proposed.

Postulate

Our world is regarded as a continuous, homogeneous, and isotropic continuum of matter–space–time, or as a unified field of energy density.

Axiom

By virtue of the continuity, homogeneity, and isotropy of the world, the dynamics of matter is limited to the only possible wave form. Accordingly, the local energy density of the field is related to the phase parameters of the single wave function of the continuum.

Planck Physics

The fundamental basis of unified field physics is Max Planck’s Natural System of Units, which explicitly points to the direct equivalence or relativity of the parameters of matter, space, and time.

$$\left(\varepsilon_p = \sqrt{\frac{\hbar c^5}{G}} \right) \asymp \left(m_p = \sqrt{\frac{\hbar c}{G}} \right) \asymp \left(l_p = \sqrt{\frac{\hbar G}{c^3}} \right) \asymp \left(t_p = \sqrt{\frac{\hbar G}{c^5}} \right) \quad (1)$$

Being derivatives of three fundamental constants, these units are invariant—they, too, are constants. Physics built upon them implies the following:

Axiom 1

Sizes smaller than the units of the “Natural System” do not exist in nature*. They contradict the constant picture of the world (1). In this regard, all field parameters are integer-valued.

$$(L_n = nl_p), \quad (T_n = nt_p), \quad (E_n = n\varepsilon_p) \quad n \in N, \{1 \leq n \leq N_{max}\} \quad (2)$$

Differential calculus, as accepted in modern science, has a lower limit of values in the form of Planck quantities. A differential “tending to zero” cannot overcome it. Derivatives of the first and higher orders become indeterminate and should be replaced by finite differences over integer modes. In macroscopic analysis, differential calculus is perfectly acceptable, since Planck quantities are extremely small against the background of anthropic scales.

Axiom 2

All field parameters of individual systems are relative. A change in one of them requires a proportional change in the others:

$$\{L = (n \pm 1)l_p\} \vdash \{T = (n \pm 1)t_p\} \vdash \{E = (n \pm 1)\varepsilon_p\} \quad n \in N, \{1 \leq n \leq N_{max}\} \quad (3)$$

The relativity of scale units is formally confirmed by the fact that all fundamental constants can be expressed through a nearly infinite (n) set of uniform parameters. The structure of the world is fractal.

$$n \in N, \{1 \leq n \leq N_{max}\}$$

$$c = \frac{nl_p}{nt_p} \quad \varepsilon_p = m_p \left(\frac{nl_p}{nt_p} \right)^2 = m_p c^2 \quad G = \frac{(nl_p)^3}{(nt_p)^2 (nm_p)} = \frac{(nl_p)^5}{(nt_p)^4 (n\varepsilon_p)} \quad (4)$$

Axiom 3

The possibility of a scalable expression of the metric of the world (4) also confirms that its continuity, homogeneity, and isotropy underlie its universal wave uniformity.

Axiom 4

The maximum permissible value of energy density is associated with the wave phase, all of whose parameters are equal to unity (the lower limit of differentiability):

$$\rho_{max} = \left(\frac{3}{4\pi} \right) \cdot \left(\frac{\varepsilon_p}{l_p^3} \right) = \left(\frac{3}{4\pi} \right) \cdot \frac{\sqrt{\frac{\hbar c^5}{G}}}{\left(\sqrt{\frac{\hbar G}{c^3}} \right)^3} = \left(\frac{3}{4\pi} \right) \cdot \left(\frac{c^7}{\hbar G^2} \right) = 1,1 \times 10^{113} \frac{J}{m^3} \quad (5)$$

By analogy with the ideas of Quantum Field Theory, this phase can be compared to a material point whose interaction with similar objects is carried out through a superposition of macroscopic waves or, in the language of the same theory, through the interaction of force fields.

Axiom 5

The Max Planck constant in the interpretation of Paul Dirac is specific. It indicates the discreteness of energy values and is associated with electromagnetism. Therefore, its fractal property indicates the parametric relativity of the energies of gravitation and electromagnetism.

$$|km_p c^2| = |k\hbar\nu_p| \quad k \in N \quad (6)$$

Axiom 6

The interval of an event in the unified field is expressed in terms of the units of the “Natural System” (2).

To conjugate the unit of matter with the units of distance, the Karl Schwarzschild radius is used for the unit wave phase (5), which is comparable to a material point having the limiting energy density and the Planck mass:

$$r_s = \frac{2Gm_p}{c^2} = 2l_p \rightarrow l_p = \frac{1}{2}r_s \quad (7)$$

$$(\Delta s)^2 = -(t_p c)^2 + l_{px}^2 + l_{py}^2 + l_{pz}^2 + \left(\frac{Gm_p}{c^2}\right)^2 \quad (8)$$

It can be noted that, on the basis of Hermann Minkowski’s five-dimensional analogue of space, this equation is represented as the squares of three orthogonal radius-vectors, two of which (temporal and material) are one-dimensional and one (spatial) is three-dimensional:

$$-(t_p c)^2 = r_t^2 \quad (l_{px}^2 + l_{py}^2 + l_{pz}^2) = r_l^2 \quad \left(\frac{Gm_p}{c^2}\right)^2 = r_s^2 \quad (9)$$

These radii are noncommutative, so the event interval should be defined as a quaternion:

$$\Delta s = ir_t + jr_l + kr_s$$

$$k = ij \neq ji = -k \quad i^2 = j^2 = k^2 = -1 \quad (10)$$

The imaginary units of the quaternion are algebraically identical to the Wolfgang Pauli matrices up to a factor.

$$e_1 = -i\sigma_1 \quad e_2 = -i\sigma_2 \quad e_3 = -i\sigma_3 \quad (11)$$

This connects it with William Clifford's algebra and Paul Dirac's equation, whose formalism will be presented in a new interpretation below.

Spin-Impulse Quantum of Energy

Max Planck's calculation of the quantum of energy (1) indicates that the momentum energy (G) is physically related to the angular momentum energy ($\hbar$), which is realized on the light cone (c) which seems improbable. These geometrodynamics forms are considered by science to be non-additive or, in wave terms, incapable of superposition. Another conclusion is that no other forms are observed in nature. There are only two:

1. Dissipative—radial-impulse.
2. Damped—angular-impulse.

Geometrically, dissipation looks like an infinite increase in the radial parameters of a spherical wave phase, while damping looks like a continuous slowdown in the rotation of the same phase due to an infinite increase in its radius. In the absence of energy losses in the continuum, their continuous coexistence or stability and a parametrically defined phase sequence (4) are possible only under the condition of a continuous transformation of one form into the other. Only with an absolute balance of local energy do dissipation and damping disappear, and the geometrodynamics remains unchanged. "Material points" and their fields remain eternal. Realizing that all of this can occur only on the scale of the accepted units of measurement, the following balance equation can be proposed:

$$\left| \frac{1}{2} m_p c^2 \pm \delta_i \right| \wedge \left| \frac{1}{2} \hbar \nu_p \mp \delta_s \right| \cup \varepsilon_p \quad (12)$$

where:

$\pm \delta_i$ – defect in impulse energy dissipation;

$\mp \delta_s$ – defect of spin energy damping.

Here we consider the kinetic part of the energy, or the equivalent of the rest mass of the material point mentioned in Axiom 4, and its spin equal to $\frac{1}{2} \hbar$. Both have an effective meaning.

The total energy of this quantum is 2. The second unit is the potential part of the energy of the two components (the sum of the defect moduli [12]), spent on replenishing dissipation and damping or on the free, inertial motion of the quantum.

In Hermann Minkowski's five-dimensional analogue of space, adopted as the analytic basis of the continuum, each of these forms must be associated with a different set of hyperplanes, reflecting their non-additivity.

$$\epsilon_{G\hbar} \ni \left| m_p c^2 \right| \wedge \left| \hbar \nu_p \right| \cup 2\varepsilon_p \quad (13)$$

Both components of this quantum have a tensor character. Momentum is a first-rank tensor, and spin is a second-rank tensor. The previously identified condition of stability or partial conversion of their energy implies, within the framework of the principle of least action, the counter-direction and collinearity of these tensors.

Accordingly, the vector sum of the components, taking into account their energy defects, should be equal to zero. However, the vector-radial symmetry of the gravitational component of the quantum and the orthogonal asymmetry of the spin component cannot but lead to a certain violation of collinearity or, in other words, to a balance defect in favor of gravitational energy, since the stability of symmetry is higher than the stability of asymmetry.

$$\vec{\epsilon}_{Gh} = \vec{\epsilon}_{pi} + \vec{\epsilon}_{ps} = \vec{\delta}_i \quad (14)$$

This expression is the equation of the physical vacuum, the most voluminous part of our world, studied at the beginning of the last century by Paul Dirac. It is also the only source of the rest mass of the quantum. It has a geometric origin and does not require the introduction of external fields (the Peter Higgs mechanism) or renormalization. The mass of a particle is determined by the magnitude of the violation of collinearity between the momentum and spin components. It is constant, the masses are unchanged! The problem of the gradation of elementary particle masses is solved.

$$m_{\in Gh} = m_p \cdot \theta_{Gh} \quad \theta_{Gh} = \text{const} \quad (15)$$

where: the angle θ_{Gh} of violation of spin-impulse collinearity. For an electron, this value is on the order 10^{-23} of radians. The analytical definition of this angle is not yet clear.

The Möbius Strip

The quaternion interval of the event (10) is an algebraic form of the Möbius strip, whose wave analogy reveals the general physics of the microprocesses of the five-dimensional continuum, or energy density field.

The three imaginary units of the interval correspond to three dynamic analogues of the strip: the momentum realized along the midline, the spin realized at the edge of the strip, and the precession of the spin associated with the special geometry of the ribbon edge. The noncommutativity of the quaternion units reflects the non-additivity of the strip's components. The imaginary units correspond to the non-orientability of the strip's surface.

The accepted energy balance (12, 13), or the assumption of the existence of a composite quantum, requires the determination of a form of correlation between the non-additive values of momentum and spin - that is, their empirical equality (6). To solve this problem, let us apply the form of a material wave in the shape of a Möbius strip nested in the five-dimensional space of the continuum, centered on the event interval.

In such a space, the strip is realized on the factor-space of four squares:

$$M = \bigcup_{k=1}^4 ([0,1] \times [0,1])_k / \sim$$

where the relation “ $\sim$ ” is given as follows: $(0, \tau)_k \sim (1, 1 - \tau)_k \quad \tau \in [0,1]$

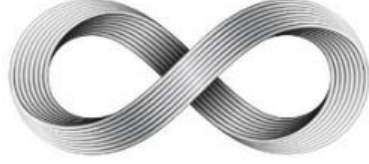


Figure 1. Möbius strip $G\hbar$ quantum

Topological Invariants of the Strip

- 1. Fundamental group $\pi_1(M) \cong Z$
- 2. Euler characteristic $\chi(M) = 0$
- 3. First Stiefel-Whitney class $w_1(M) \neq 0 \in H^1(M, Z_2)$

Parameterization Equation of a 5D Möbius Strip

where the five dimensions are represented as follows:

$$\mathcal{M}_{(nl_p\theta\varpi\beta)} = \begin{bmatrix} R_n \cos \theta \left(1 + \frac{\varpi}{2} \cos \frac{\theta}{2}\right) \\ R_n \sin \theta \left(1 + \frac{\varpi}{2} \cos \frac{\theta}{2}\right) \\ \frac{\varpi}{2} \sin \frac{\theta}{2} \cos \beta \\ \frac{\varpi}{2} \sin \frac{\theta}{2} \sin \beta \\ \frac{\varpi}{n} \end{bmatrix} \quad (16)$$

$n \cdot l_p = R_n \quad n \in N \quad n \geq 1$ – scaled radius of the ribbon midline;

$\theta \in [0, 2\pi]$ – angular coordinate along the midline of the strip (full rotation);

$\varpi \in [-1, +1]$ – the coordinate across the strip, its width normalized;

$\beta \in [0, 2\pi]$ – the internal parameter of the quaternion, equivalent to the SU (2) matrix.

$$\left[\left\{ q_{(\beta)} = \cos \frac{\beta}{2} + \sin \frac{\beta}{2} \hat{v} \right\} \quad \{ \hat{v} = v_x \mathbf{i} + v_y \mathbf{j} + v_z \mathbf{k} \} \quad \{ v_x^2 + v_y^2 + v_z^2 = 1 \} \right] \sim (S^3 \cong SU(2))$$

It is geometrically proportional to the ratio of the twist constant (1, 2, 3, ...) to the radius of the midline: the smaller the radius, the shorter the midline, and the steeper the twist angle per unit of its length.

The fifth component of the strip parameterization has a special meaning. It shows the ratio of oscillation periods of the correlated spin and impulse components of a single wave phase. Theoretically, they should be equal to unity, so this parameter of the strip should also be equal to unity. However, there is a factor that can disrupt this ratio. This is the precession of spin associated with the geometry of the strip. Its axial vector is orthogonal to the axial vector of spin.

Due to the geometry of the strip, the ratio of the average lengths of the midline and the edge is 1:2. Therefore, the effective spin of the strip as a physical unit is $\frac{1}{2}$ (a fermion), and the total spin at the edge of the strip is 1 (the basis of electric charge). It is realized over a 4π rotation due to precession—that is, its cycle ends after two impulse periods.

In absolute terms, all precession parameters are identical to the spin parameters. However, precessional time inserts cannot but introduce some defects into spin interactions. If spin is regarded as a gyroscope, then precession is represented as an external force that meets resistance. This can be the reason for the repeatedly accumulated defect equal to 137 units of time, or 137 quanta of energy. I suppose this is how the fine-structure constant—which is an analogue of electric charge—arises:

$$\frac{\varpi}{n} = \frac{t_p}{137t_p} = \frac{1}{137} = \alpha \quad (17)$$

Physics of the Correlation of the Impulse and Spin Components

A strip is a formal, or geometric, representation of a complex material wave that includes momentum and spin components. The former is associated with an unoriented surface, or with the midline of the strip, and the latter with the edge, or twist, of the ribbon. The phase velocity of both the impulse and spin components is the same (c), but the two are topologically separated. Each is realized in a different set of hyperplanes, or four squares of the factor-space of a single Möbius strip.

The amplitudes of the components are the same, proportional to the surface energy density of the strip. The ratio of the conventional lengths of the midline and the edge indicates the value of the effective spin. The conventional radius of the edge is twice that of the midline. In one complete cycle of the impulse component, the spin component completes only half a cycle—that is, the effective spin is $\frac{1}{2}$ —a fermion!

Another feature of the Möbius strip becomes extremely interesting. A complete spin cycle must be accompanied by a complete precessional cycle - that is, a rotation of the spin pseudovector in a plane perpendicular to the momentum (across the strip).

If momentum and spin are associated with gravity and electrostatics, then what should the precession of spin be associated with? Energetically, it is equivalent to spin, so we may assume that it should be associated with magnetism. The precession of the spin current creates a static magnetic field - an anomalous magnetic moment ($g=2$). Geometrically, the magnetic moment coincides with the midline of the spin pseudo-torus (a closed spiral of precessing spin stretched along the midline). It looks like an induction coil!

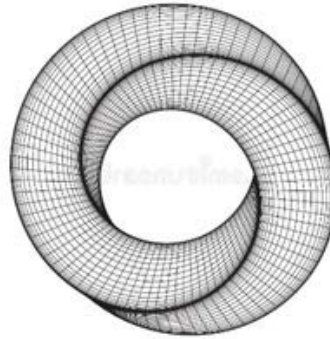


Figure 2. Precession of spin on the Möbius strip

In view of the above, we can conclude that the Möbius strip is an ideal model of the simplest fermion - an electron or a positron.

Purely formally, the model under consideration can be represented as three non-additive radius-vectors connected by two ideal symmetries:

1. The momentum energy tensor, first rank, is realized along the midline of the strip.
2. The spin energy tensor, second rank, is realized at the edge of the ribbon, collinearly with the momentum vector (symmetry 1).
3. The energy tensor of spin precession, second rank, is realized on the circumference of the pseudo-torus, or on the twist of the ribbon, orthogonal to the axial vector of spin (symmetry 2).

In the interaction of quanta, symmetries cannot but be violated. At the same time, the formal values of these violations cannot but be associated with the general laws of Planck physics (Axioms 1–6). Therefore, the basis of QCD should be sought here.

Dirac Equations in the Quaternion Algebra of the Möbius Strip

The two non-additive components of the quantum—momentum and spin—formally (purely geometrically) correspond to the two Hermann Weyl spinors in Paul Dirac's view.

The imaginary units of the quaternion of the event interval are algebraically identical to the Wolfgang Pauli matrices up to a factor.

$$\begin{aligned}
e_1 &= -i\sigma_1 & e_2 &= -i\sigma_2 & e_3 &= -i\sigma_3 \\
\sigma_1 &= \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} & \sigma_2 &= \begin{pmatrix} 0 & -i \\ i & 0 \end{pmatrix} & \sigma_3 &= \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \\
e_1 e_2 &= e_3 & e_2 e_1 &= -e_3 & e_1^2 &= e_2^2 = e_3^2 = -1
\end{aligned} \tag{18}$$

This relates the event interval to William Clifford's algebra and Paul Dirac's gamma matrices, as envisioned by Hermann Weyl:

$$\gamma^0 = \begin{pmatrix} 0 & I \\ I & 0 \end{pmatrix} \quad \gamma^i = \begin{pmatrix} 0 & e_i \\ -e_i & 0 \end{pmatrix} \quad i = 1, 2, 3 \tag{19}$$

The gamma matrices satisfy the Clifford algebra:

$$\{\gamma^\mu, \gamma^\nu\} = \gamma^\mu \gamma^\nu + \gamma^\nu \gamma^\mu = 2g^{\mu\nu} I_4 \tag{20}$$

where:

1. $g_{\mu\nu}$ - the metric of Minkowski space;
2. I_4 - diag 4I unit Weyl matrix.

Then the Dirac equation in the quaternion form of the Möbius strip has the following form:

$$(i\gamma^\mu \partial_\mu - m)\psi = 0$$

where:

ψ - a four-component Dirac spinor, equivalent to two symmetric two-component Weyl spinors: left and right: $\psi = \begin{pmatrix} \psi_L \\ \psi_R \end{pmatrix}$ the left spinor is the spin component of the Möbius strip, and the right spinor is the momentum component;

γ^μ - gamma matrices built on quaternion units;

$\partial_\mu = \left(\frac{1}{c} \cdot \frac{\partial}{\partial t} \nabla\right)$ - the four-component action gradient;

$m = (m_p \cdot \theta_{G\hbar})$ - the mass determined by the angle of violation of collinearity of the momentum and spin energy y tensors.

To verify the obtained relation, let us square the resulting Dirac equation, taking into account the noncommutativity of its components. We obtain the Klein–Gordon equation:

$$(\square + m)\psi = 0 \Rightarrow E^2 = p^2 c^2 + m^2 c^4 \quad (21)$$

Conclusion: Paul Dirac's formalism is an emergent consequence of the quaternionic expression of the event interval in the five-dimensional space of a unified field of energy density.

Unified Wave Function

The parameters specified in formula (16) constitute a specific definition of a quantum, or the simplest material particle of our world, characterized by five parameters that are capable of influencing interactions in one way or another. For example, the effective spin $\frac{1}{2}$ defines this particle as a fermion whose charge is equivalent to the integer spin and the speed of light.

The presence of a quantum number “n” in the parameters of the strip indicates the modal structure of the wave function. Geometrically, this is similar to a sequence of nested five-dimensional phase spheres with a radial periodicity equal to a unit of length. The surface energy density of such spheres, taking into account quantum certainty and the coupling of wave parameters, is determined for gravity as follows:

$$\psi_i = \rho_n = \frac{n\varepsilon_p}{4\pi(nl_p)^2 l_p} = \frac{1}{n} \cdot \frac{\varepsilon_p}{4\pi l_p^3} \propto \frac{1}{n} \cdot \varepsilon_p \quad n \in N, \{1 \leq n \leq N_{max}\} \quad (22)$$

Surface is considered as a physical volume equal to the product of the sphere area and the unit of distance.

This equation refers to the total energy of the gravitational field of a material point (5). Its value is related to the nearly infinite sum of the harmonic series:

$$E_G = \varepsilon_p \cdot \sum_{n=1}^{N_{max}} \frac{1}{n} \approx \varepsilon_p (\ln N_{max} + \gamma) \quad (23)$$

where $\gamma \approx 0,57721$ is the Leonhard Euler–Lorenzo Mascheroni constant.

If we take the scale of quantum mechanics ($10^{20} l_p$), then the sum of the series will be $\approx 46,052 + \gamma \approx 46,629$. That is, the total gravitational energy of the Planck mass on the scale of quantum mechanics will be exactly 47 quanta - fractional approximations represent the inherent uncertainty of the logarithmic sum (23).

The spin component has its own specifics. Its essence lies in the fact that its value is influenced by the fifth coordinate of the Möbius strip (16), which is the ratio of the width of the band (the main characteristic of spin) to the radius of its midline (the main characteristic of momentum). This is the chromodynamic indicator that sets the level of asymmetry of the two components: gravity–momentum and electrostatics–spin during interaction. I believe that this is the well-known fine-structure constant that determines the charge from the “Natural System of Units.”

$$V = \frac{\varpi}{n} = \frac{1}{137} = \alpha \quad (24)$$

It follows from this correlation that the electrostatic field has its own set of 5D spherical modes, distinct from the gravitational ones, combined with the gravitational series.

The energy density of the electrostatic modes is determined by the relation:

$$\psi_s = \rho_s = \frac{n137\hbar\nu_p}{4\pi(n137l_p)^2 l_p} = \frac{1}{n137} \cdot \frac{\hbar\nu_p}{4\pi l_p^3} = \frac{1}{n} \cdot \frac{\alpha\hbar\nu_p}{4\pi l_p^3} \quad n \in N, \{1 \leq n \leq N_{max}\} \quad (25)$$

This equation shows that the electric and magnetic charges are in some way related to the total energy of the 137 spin levels, while the mass of the charge is related to only one—the first level of the gravitational component (12):

$$q_e \sim q_\mu \sim \left\{ \hbar\nu_p \cdot \sum_{k=1}^{137} k = (\hbar\nu_p \cdot 9453) \right\} \quad (26)$$

The limiting energy density of charges is equal to:

$$\rho_q = \frac{3 \cdot 9453 \cdot \hbar\nu_p}{4\pi(137 \cdot l_p)^3} = 4,07 \times 10^{107} \frac{J}{m^3} \quad (27)$$

This is 6 orders of magnitude less than the limiting density of gravitational energy (5).

Taking into account the precessional, or magnetic, component, the unified energy density function is represented by three non-additive components: two orthogonal spin elements (non-additivity - the Wolfgang Pauli exclusion principle) and momentum!

It can be regarded as the energy field of an electron, or as an analogue of the Lagrangian of a Gh quantum.

$$\psi_{is} \ni \left[\left(\frac{2}{n} \varepsilon_p \right)_i \wedge \left(\frac{1}{n} \alpha \hbar \nu_p \right)_s \wedge \left(\frac{1}{n} \alpha \hbar \nu_p \right)_\sigma \right] = \frac{1}{n} [2\varepsilon_{pi} \wedge \alpha \hbar \nu_{ps} \wedge \alpha \hbar \nu_{p\sigma}] \quad (28)$$

$n \in N, 1 \leq n \leq N_{max}$

where:

1. i – impulse;
2. s – spin;
3. σ – precession.

The Quantum Form of Isaac Newton's and Albert Einstein's Laws

A unified field can be thought of as a gradient with respect to energy density. That is, interaction is associated with a superposition, or a vector sum, of gradients.

The basic wave equation representing the gravitational energy density distribution of a single quantum unit of mass is as follows (22):

$$\psi_i = \rho_n \propto \frac{1}{n} \varepsilon_p \quad n \in N \leq N_{max} \quad (29)$$

Accordingly, the gravitational energy density gradient is represented as follows:

$$\varphi_{(\vec{r})} = \nabla \psi_{(n)}^{im} \cdot \left(\frac{\vec{l}_p}{l_p} \right) = \varepsilon_p \vec{r} \cdot \left(\frac{1}{n} - \frac{1}{n+1} \right) = \varepsilon_p \vec{r} \cdot \frac{1}{n(n+1)} \quad (30)$$

where $\left(\frac{\vec{l}_p}{l_p} \right)$ is the unit vector of the radial direction.

$$l_p^2 n(n+1) \cong R_n^2 \quad n > 1 \quad (31)$$

As a result of deciphering the quantum of energy—substituting the unit distance into the numerator and the denominator, and switching to modular quantities we obtain the following:

$$\left| \varphi_{(\vec{r})} \right| = \left(\frac{l_p^3}{t_p^2} \right) \frac{m_p}{R_n^2} \rightarrow \left(\frac{l_p^3}{t_p^2 m_p} \right) \cdot \frac{m_p \cdot m_p}{R_n^2} = G \cdot \frac{m_p \cdot m_p}{R_n^2} \quad (32)$$

This is Isaac Newton's equation of gravitational force, but with a radical difference. We are considering a material field with a limit on the velocity of gravitational waves, “c.” Interestingly, this formula works over the entire depth of the field, down to a single unit of distance ($n = 1$) and down to a single Planck mass!

It is just as easy to test covariance with respect to General Relativity by considering a single condition: the quantum number $n \gg 1$. On this scale, Hermann Minkowski space appears to be practically flat, and Albert Einstein's tensor takes the classical form:

$$G_{\mu\nu} = \frac{8\pi G}{c^4} T_{\mu\nu} \quad T_{\mu\nu} = \text{diag}(\rho c^2, p, p, p)_{\mu\nu} \quad (33)$$

From equation (22), the energy density and gravitational pressure are equivalent and equal to:

$$\rho = \frac{\varepsilon_p}{4\pi r l_p^2} \quad p = \rho c^2 \quad (34)$$

Substituting these values into Einstein's equation yields all the components of the tensor.

$$G_{00} = \frac{8\pi G}{c^4} \rho c^2 = \frac{2}{r l_p} \quad G_{rr} = \frac{8\pi G}{c^4} \rho c^2 g_{rr} = \frac{2}{r l_p} g_{rr} \quad (35)$$

$$G_{\theta\theta} = \frac{8\pi G}{c^4} \rho c^2 r^2 = \frac{2r}{l_p} \quad G_{\phi\phi} = G_{\theta\theta} \sin^2 \theta = \frac{2r}{l_p} \sin^2 \theta$$

The resulting components have dimensions corresponding to general relativity. They are greatly simplified by the formalism of the quantum field, down to the Planck value of length. They show no signs of singularity but reach their maximum value at a radius equal to 1. The energy density contains the sign of rotation (1/r) ****.

The structure of the unified field naturally generates a gravitational field that corresponds to the General Theory and contains predictive factors for astrophysics.

Conclusion: both the theory of Isaac Newton and the theory of Albert Einstein lose their fundamental character and become emergent with respect to the unified field of energy density.

The Quantum Form of Charles Augustin de Coulomb's Law

The wave function of the spin component of the unified field can be considered in the form of a spin energy density gradient (16):

$$\psi_{s(n)} = \frac{n137\hbar\nu_p}{4\pi(137nl_p)^2 l_p} = \frac{1}{n} \cdot \frac{\alpha\hbar c}{4\pi l_p^2} \quad n \in N \leq N_{max} \quad (36)$$

where $\vec{r}$ is the unit vector of the radial direction.

$$\varphi_{s(\vec{r})} = \nabla \psi_{s(n)} \cdot \left(\frac{\vec{l}_p}{l_p} \right) = \vec{r} \cdot \frac{\alpha\hbar c}{4\pi l_p^2} \left(\frac{1}{n} - \frac{1}{n+1} \right) = \vec{r} \cdot \frac{\alpha\hbar c}{4\pi} \frac{1}{l_p^2 n(n+1)} \quad (37)$$

where $\left(\frac{\vec{l}_p}{l_p} \right)$ is the unit vector of the radial direction - $\vec{r}$.

$$l_p^2 n(n+1) \cong R_n^2 \quad n > 1 \quad (38)$$

$$|\nabla \psi_{s(n)}| = \frac{\alpha\hbar c}{4\pi R_n^2} \quad (39)$$

“ α ” is equivalent to the square of the electron charge through the Planck charge.

$$e^2 = \alpha q_p^2 \quad (40)$$

Therefore, the Coulomb constant can be expressed as follows: $k = \frac{\hbar c}{q_p^2}$

. Then, converting the energy gradient into the Coulomb force yields the following expression:

$$F_{en} = \frac{\hbar c}{q_p^2} \cdot \frac{e^2}{R_n^2} = k \frac{e \cdot e}{R_n^2} \quad (41)$$

As can be seen, an exact expression of Coulomb's force law for electron charges has been obtained. It remains to calculate the electric constant. Within the framework of the applied Planck formalism, it is a function of the squares of the electron charge and the Planck charge.

$$\varepsilon_0 = \frac{q_p^2}{4\pi\hbar c} = \frac{e^2}{4\pi\alpha\hbar c} \quad (42)$$

Quantum Forms of the Strong and Electroweak Interactions

In the structure of the equations considered, the definition of the strong and electroweak interactions seems quite obvious. Isaac Newton's formula makes it possible to determine the strength of the interaction of two mass quanta at a distance equal to unity.

$$F_G = G \frac{m_p^2}{l_p^2} \sim 10^{42} \text{H} \quad (43)$$

The same applies to Charles Augustin de Coulomb's equation for two charges of an electron-positron pair.

$$F_e = k \frac{e^2}{(137 \cdot l_p)^2} \sim 10^{37} \text{H} \quad (44)$$

The values found allow us to assume that such calculation structures correspond to the forms of interaction under consideration.

At the same time, the gravitational energy density gradient on scales close to unity is five orders of magnitude greater than the energy density gradient of electromagnetism. Therefore, the gravitational bond of quanta can be associated with the **gluon**, and the electro - (conventionally **W**) - magnetic (conventionally **Z**) bond with the boson.

Matter–Antimatter

Another interesting property of the Möbius strip is that it is symmetrical, both geometrically and physically, under mirror reflection. That is, we can speak of matter–antimatter.



Figure 3.

Mirror symmetry of the asymmetric elements of matter and antimatter

The proposed figure shows that all three tensor components of the composite energy quanta are directed strictly in opposite directions. That is, their interaction must be antisymmetric:

1. impulse–anti-impulse, gravity–antigravity;
2. spin–anti-spin, electromagnetism–anti-electromagnetism.

Annihilation is impossible because coexistence in the same location is impossible. Matter and antimatter must be constantly moving away from each other. Our Universe is divided into two worlds: the world of matter and the world of antimatter. In them, wave microprocesses are antisymmetric, and superposition is excluded.

In this regard, it becomes clear why the electron and positron belong to the material world: their impulse components are directed toward each other, they attract, and therefore can annihilate.

A Revolution in Cosmology and the Origin of Dark Matter

Obviously, such a world is divided roughly 50% to 50% in terms of content. At the same time, the most likely scenario is an infinite number of mixed clusters, actively moving away from each other due to antigravity, and also actively contracting under their own gravity. The compression of clusters to the maximum energy density is accompanied by an electron–positron annihilation explosion, as a result of which matter and antimatter appear.

They scatter and redistribute among existing and newly formed clusters. And so on, ad infinitum, in space and time. The Universe is like an endless series of local explosions and local condensations. Perhaps it looks like a dynamic foam, where bubbles collapse and inflate.

A phenomenological Lagrangian of such a universe is proposed:

$$\mathcal{L}_{+-} = \frac{1}{2}(\partial_\mu \Phi_M)^2 + \frac{1}{2}(\partial_\mu \Phi_A)^2 - \frac{\lambda}{4}(\Phi_M^2 - v^2)^2 - \frac{\lambda}{4}(\Phi_A^2 - v^2)^2 - \frac{\mathcal{A}}{2}\Phi_M^2\Phi_A^2 \quad (45)$$

where:

$\mathcal{A} > 0$ – the antigravity constant between the world of matter and the world of antimatter $\Phi_M\Phi_A$;

λ – a scale, phenomenological parameter of the world, possibly the quantum constant k ;

v – vacuum energy density (10) between clusters;

$\frac{\mathcal{A}}{2}\Phi_M^2\Phi_A^2$ – negative pressure, the accelerated expansion factor.

The antigravity constant is still a phenomenological parameter, but its value can be determined from cosmological observations (the rate of accelerated expansion).

At the same time, most of the matter and antimatter are hidden in a vacuum, having a dark form equivalent to the impulse component, or Planck mass, hidden within the quantum. The mass, or mass equivalent, of elementary particles is a small part, whose energy is comparable to the mass of a quantum, or electron–positron. A quantized Lagrangian of dark matter is proposed:

$$\mathcal{L}_{BM} = \frac{1}{2}(\partial_\mu \mathcal{X})^2 - \frac{1}{2}m_p^2 \mathcal{X}^2 + \sqrt{-g} \left(\mathcal{X}^2 \xi R - \theta \frac{\varepsilon_p}{l_p^3} \mathcal{X} \right) \quad (46)$$

where:

$\theta = 10^{-23}$ – the estimated parameter of the quantum mass;

m_p – unit of mass, Planck value;

ξ – the coupling constant with curvature R ;

$\frac{\varepsilon_p}{l_p^3}$ – maximum field energy density;

$\mathcal{X}$ – the field hidden in the quantum of the total energy of the momentum.

Fundamentals of Quantum Chromodynamics

My knowledge of modern chromodynamics is very limited, so I will try to offer the basics of my hypothesis as applied to this area.

Obviously, all existing forms of the Standard Model can arise only in regions where the energy density is close to the limiting value of (5)(27)—that is, at distances close to a unit of distance. Here, the gradients of the energy density of momentum and angular momentum reach their maxima, up to $\frac{1}{2}$ of the Planck unit of energy per unit distance. At the same time, the gradient of the momentum energy density increases significantly faster than the gradient of the spin energy density as the quanta approach each other. The force of gravitational attraction (43) is 5 orders of magnitude greater than the electrostatic force (44). Therefore, I will take the liberty of asserting that the strong and electroweak interactions are not associated with any fundamental fields. These are forms of gravitation and electromagnetism on very small scales close to 1. $(\varepsilon_p)(\varepsilon_p)(\pm)$

Taking into account the topological basis of particles and their fields, it can be assumed that complex elements of matter—neutrons, protons, and others containing two or more particles in their structure are formed by the cohesion, or entanglement, of single Möbius strip, or, as was mentioned earlier, electrons–positrons.

Confinement

In the region of limiting energy density five-dimensional, spin-impulse waves of two quanta (an electron and a positron) can undergo a kind of super positional fusion, or entanglement of their

ribbons, by combining along one of the gravitational squares of the factor-space (16). Such cohesion can be identified as a gluon. That is, confinement is not an exchange of gluons, as interpreted in standard QCD, but an energy-stable superposition of the gravitational components of two or more quanta.

The sum of the energies of the merged squares cannot exceed one quantum, so part of the energy—the second quantum—is released. It is this that can be correlated with the gluon. This is the very defect of gravitation that must be balanced by the defects of the two spin and two precessional components of the interacting quanta. They obey the Pauli exclusion principle. All their axial vectors must be orthogonal. The transition to mutual orthogonality of the four axial vectors requires an energy expenditure. This is the defect of spin and precessional energy—the W and Z bosons. The mutual orthogonality of the four originally collinear vectors creates an electromagnetic symmetry that defines the QCD charge unit—colorlessness—inherent in such a binary boson as a photon.

Such a confinement mechanism can be proposed for more complex particles, such as quarks and baryons. The principle is that three Möbius strips can be formally aligned on four squares of the same factor-space:

Post		Q_1	Q_2	Q_3	Q_4
A		Q_1	Q_2	Q_3	Q_4
B		Q_1	Q_3	Q_4	Q_2
C		Q_1	Q_4	Q_2	Q_3

Table 1

Table 1. Post

The square is stationary in all three ribbons—the result of the superposition of gravitational components and the permutation of spin–precessional components. It is also the axis of rotation. In this case, the result of the permutation can only take the form of a triangle (Pauli exclusion):

$$Q_2 \frac{2\pi}{3} \rightarrow Q_3 \frac{2\pi}{3} \rightarrow Q_4 \frac{2\pi}{3} \rightarrow Q_2 \quad (47)$$

All three ribbons are equivalent, and none is isolated. Colorlessness follows from geometry—the complete cycle of 2π is identical to the sum of the bypass phases. A possible permutation of three of the three spin–precessional doublets is 6. It can be interpreted as six quarks. The unification of quark triples within the framework of electromagnetic symmetry, or the electroweak interaction, produces a neutron and a proton.

Thus, the triangular symmetry of ribbons based on gravity solves all the problems of baryon formation. Everything is determined by gravity and electromagnetism.

Asymptotic Freedom

The first modes of the wave function, or quanta (28), are regions of a unified field with a maximum permissible energy density, where the density gradient vanishes. Space and time acquire their maximum permissible parameters.

Color as the Topology of the Edge of a Möbius Strip

I assume that within the framework of the model under consideration, the three colors of standard QCD correspond to three possible variants of the orientation of the axial vectors of the spin–precessional pair with respect to the direction of the momentum vector. The edge of the Möbius strip can be twisted in three ways, corresponding to the three-cube roots of unity in the plane of precession.

$$w_k = e^{\left(\frac{2}{3}\pi ik\right)} \quad k \in \{0,1,2\} \quad (48)$$

These three configurations are non-additive (Pauli exclusion), but within the framework of the confinement of three strips, or when pairs of squares of the same factor-space of Möbius strips are combined, the total asymmetry of the edges turns into symmetry, which can be identified with the colorlessness of standard QCD.

QCD Lagrangian

The unified wave equation of the energy density (28) of the quantum field contains three components, which, as we have found, are three color charges in three topologically defined configurations, and can be regarded as a QCD Lagrangian.

$$\mathcal{L}_{\text{KХД}} = *_5 \{ \psi_i^c \wedge \psi_s^c \wedge \psi_\sigma^c \}_{n=1} \quad c \in \{r, g, b\} \quad (49)$$

where: $*_5$ – five-dimensional; c – orientation of the ribbon edge, color; $(n = 1)$ – the first mode of the unified wave function, the limit of energy density.

As a consequence, a baryon singlet (3×3 quanta are two unions (proton, neutron) of three-color triads, or quarks):

$$\mathcal{L}_{\text{барион}} = *_5 \left[\bigcup_{c \in \{r, g, b\}} \{ \psi_i^c \wedge \psi_s^c \wedge \psi_\sigma^c \}_{n=1} \right] \quad (50)$$

Permutations of three colors each give six quarks, which corresponds to SU (3). The equation presented does not require gauge fields and SU (3) generators as primary objects. Everything is related to the topology of the Möbius strip.

The dynamics of processes, as follows from the preceding text, is governed by two laws: Isaac Newton’s gravitation and Charles Augustin de Coulomb’s electrostatics. Their quantum forms are given earlier (32, 41). Joseph Louis Lagrange’s equations are constructed within the framework of differential calculus, which has a limit in quantum physics. Therefore, dynamic transformations of the QCD Lagrangian (50) are not possible.

Conclusion

The proposed concept of a unified field of energy density, based on Max Planck's "Natural System" and the postulate of a continuous, homogeneous, and isotropic continuum of matter–space–time, allows us to take a fresh look at the fundamental foundations of modern physics.

The basis of the proposed work is the formulation of the "Law of Metric Certainty and Coherence of Parameters," according to which any physical parameter of a system is a multiple of an integer number of Planck units. This law limits the scope of applicability of Heisenberg's uncertainty principle and Bell's inequalities, thereby resolving the long-standing dispute between Einstein and Bohr in favor of Einstein's determinism: "God, after all, does not play dice."

The singularity in general relativity is declared to be a mathematical exaggeration, and its place is taken by a region of limiting energy density with an event horizon defined by the Karl Schwarzschild radius.

The key topological solution is the Möbius strip, the geometry of which naturally unites and synchronizes the non-additive impulse and spin components. On its basis, analytical expressions for the fine-structure constant and the charge of the electron–positron through integers are obtained for the first time, which indicates the topological rather than random origin of these constants.

In cosmology, the mirror symmetry of the Möbius strip predicts the equal existence of the worlds of matter and antimatter, with effective antigravity between them, which explains the accelerated expansion of the universe without the involvement of Λ CDM. Dark matter is interpreted as latent gravitational energy in a quantum, or in the energy density of a vacuum.

Thus, the theories of Newton and Einstein, electrodynamics, and quantum mechanics lose their fundamental character, becoming emergent consequences of the single wave equation of the five-dimensional continuum.

The proposed formalism not only eliminates the existing contradictions of physics (singularity, the observer problem, locality) but also sets the direction for the future mathematization of quantum chromodynamics through multi-modal entangled Möbius strips. Experimental verification of the predicted integer relations for the fine-structure constant will be a decisive test of the proposed paradigm.

Suggested Experiments

№1. Verifying the Prediction of the Fine-Structure Constant

What we verify: the resulting analytical expression for the constant α .

$$\alpha = 1/137 = 0.(00729927)$$

CODATA gives: $\alpha \approx 1/137.036$.

Difference: 0.026%.

How to verify: use the experiment on the anomalous magnetic moment of the electron ($g-2$)—currently the most accurate method for measuring α (accuracy $\sim 10^{-10}$). If, after taking into account all QED corrections, the value of α is systematically shifted toward $1/137$, this will be a serious counterargument to the Standard Model and a confirmation of the proposed topological formula.

Where to perform: laboratories with LKB (Paris), Harvard (Gabrielse), and UW (Washington) facilities.

№2. Search for Ribbon Topology in Particle Decays

What we test: a model according to which an electron–positron pair is not a point particle but an excited state of a Möbius strip with quantum numbers ($n = 137$, $k = 1$). Hence the consequence: the annihilation $e^+ e^-$ should exhibit angular anomalies associated with the topological Berry phase.

How to test: in colliders (e.g., VEPP-2000, DAΦNE, Super KEKB), carry out a precise measurement of the angular distribution of gamma quanta during $e^+ e^-$ annihilation. Standard QED predicts a smooth distribution ($\sin^2 \theta$). The model, due to the spiral edge of the Möbius strip, predicts modulation of this distribution with a period that is a multiple of $\pi/2$ and a dependence on the helical nature of the beams.

Where to perform: BINP (Novosibirsk), LNF (Frascati), KEK (Tsukuba).

Forecast: with statistics of $>10^9$ events, a deviation of $\sim 10^{-5}$ – 10^{-6} from QED can be detected.

№3. Search for Antigravity Between Matter and Antimatter

What we test: the thesis from the cosmological part that the interaction of clusters of matter and antimatter produces negative pressure and antigravity (constant Λ in the Lagrangian $L_{\leftrightarrow}$).

How to test: search for space objects or regions containing unexplained anomalies—an obvious recession of space objects from nearby visible centers of attraction, up to and including black holes.

Notes

* The idea that there are no dimensions smaller than Planck's was expressed by Planck himself (1899) and confirmed in the works of Barrow (2002) and Zhambaybekov and Yarulin (2019). References 1, 2, 3, 4.

** Werner Heisenberg's uncertainty principle, within the framework of the "Law of Metric Coupling of Parameters," does not seem to correspond to the scale of the quantum domain. In quantum units, the uncertainty relation has a strictly defined value.

$$\left(m_p \frac{l_p}{t_p}\right) \cdot l_p = \frac{1}{2\pi} h$$

All physical quantities of a system are multiples of a single integer “k.” In this particular case, $k = 1$. Therefore, the concept of fundamental uncertainty loses its meaning. The product of conjugate quantities becomes strictly deterministic, taking mathematically strict quantized values. On the scale of quantum mechanics ($\sim 10^{20}l_p$), the principle must hold, since the wave properties of elementary particles become essential. Obviously, Werner Heisenberg’s principle is a theoretical confirmation of the wave nature of our world.

Regarding John Bell’s inequalities: they are built on incomplete knowledge of the basic conditions, but they are adequate to the present paradigm. Within the framework of the formulated Law, there is a strict correlation of all the parameters of a system. Therefore, no matter what spatial-temporal parameters it may have, the measured numbers of all its parameters are always the same. The determinism of systems is absolute; it does not depend on time. A change and measurement of something in one place will always correspond to a change and measurement of something in another. The entanglement factor is a consequence of deterministic certainty and coherence.

The twenty-year dispute between Niels Bohr and Albert Einstein over “God does not play dice” seems to be resolved in Einstein’s favor. The “uncertainties and lack of locality” in quantum mechanics are merely manifestations of the wave properties of matter.

Sakharov (1967), Verlinde (2011), and Jacobson (1995) developed the idea that gravity is not fundamental but is an induced effect. References [5, 6, 7].

The Einstein–Cartan theory, developed in the works of Cartan (1922), Kibble (1961), and Hehl et al. (1976), establishes that the torsion of space-time is generated by the spin of matter. References [8, 9, 10].

The relationship between the geometric Berry phase and the topology of the Möbius strip has been experimentally demonstrated in optical microresonators (Saito et al., 2023), and theoretical models (Al Yaquob, 2026; Flouris et al., 2022) show that spin $\frac{1}{2}$ naturally arises from such a topology. References [11, 12, 13].

According to the hypothesis of Smolin (2014) and the work of Binder (2002), the fine-structure constant can be expressed in terms of integer topological parameters. References [17, 18].

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