The Positron, Positronium, and Quarks

Complete Structural Derivation in the Fundamental Gravitational Wave Framework

The positron as a twisted photon; positronium trapping and decay; quark cone angles; the gluon standing-wave dynamo; CP violation from monodirectional time

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Abstract

We present a complete structural derivation of the positron, positronium, and quarks in the Fundamental Gravitational Wave (FGW) framework. The electron and positron are both photon energy — electromagnetic waves rotated off the 45° null line into 3D space. The electron's rotation self-traps it into a standing wave, giving it rest mass m_e. The positron's opposite-twist rotation does not self-trap: a free positron is a **twisted photon**, massless, walking freely at wave speed, with no gravity. When the positron is externally trapped — held in 3D flux by an electron (positronium), by gluon dragging (a quark), or by a matter environment — it acquires rest mass m_e. Energy is always conserved because it is always EM-wave energy; gravity is sourced by rest mass (self-trapped standing-wave configurations), and is itself the bookkeeping of mass converting local time into local space — the H field. We derive the quark cone angle θ = arccos(2/3) = 48.19° from charge balance, present the explicit charge-projection integral, show the down quark as up-plus-bound-electron with charge −1/3 derived by arithmetic, and explain the gluon standing-wave dynamo that drags the quarks through time and forces the bound positrons into the gravitating configuration. CP violation is shown to require no free parameter: it is the automatic consequence of monodirectional time. The Rydberg constant R_∞ is identified as the time-to-space conversion rate per proton Compton cycle, reflecting the gluon standing-wave energy. Every result is derived explicitly; nothing is asserted without a mechanism.

1. Introduction

The positron is conventionally treated as the antimatter twin of the electron: same mass, opposite charge, related by charge conjugation. In the FGW framework the relationship is deeper and more asymmetric. The electron and positron are two different rotations of the same underlying object — photon energy on the 45° null line — and these two rotations behave very differently in a universe where time runs in one direction.

This paper derives the positron, positronium, and the quarks from the framework's axioms with every step shown. We establish what a free positron is (a twisted photon), what a trapped positron is (a massive particle), how positronium forms and decays, how quarks are cone-trapped positrons, how the gluon standing wave drags quarks through time, and how CP violation dissolves as a parameter once monodirectional time is taken seriously. The companion papers "*The Electron*" (FGW_electron) and the framework papers (FGW_particles, FGW_TOE) provide the electron derivation and the broader context; this paper is self-contained for the positron and quark sector.

2. The Substrate and the 45° Null Line

The FGW framework rests on a single wave-bearing substrate in flat 3D space. The substrate carries electromagnetic waves. A free photon is a substrate wave propagating on the **45° null line**: its time projection and space projection are equal,

$$\text{photon:} \quad (\text{time projection}) = (\text{space projection}), \quad \theta_{\text{photon}} = 45^\circ$$

Eight axioms specify the substrate. The two most relevant for this paper:

A2	Time is monodirectional. Outgoing-wave-shell solutions at central interference points select forward time.
A4	Mass exists only in the present instant as the trapped wave energy of a standing configuration. No past mass, no future mass — only the ever-present now.

3. Mass Exists Only in the Present

The foundational principle of this paper is Axiom A4: **mass exists only in the present instant**. There is no reservoir of past mass and no reservoir of future mass. Everything that exists, exists in the ever-present now.

This has a direct consequence. A massive particle, to continue existing from one instant to the next, and to move through 3D space, must continuously **make room**: it must convert local time into local space. A particle cannot simply persist for free — persistence is an active process of converting the time-stream into space.

> **Gravity, defined.** Gravity is the conservation-of-energy bookkeeping of mass converting local time into local space. The accumulated record of this conversion is the H scalar field — what we measure as local spacetime. Gravity is not a force pulling objects together; it is the necessary consequence of mass needing space to exist in, and to move through, the present instant.

A particle that does **not** need to make room — one that is not trapped in 3D space, that propagates freely like a wave — does not convert time to space and therefore has no gravity. As we will show, the free positron is exactly such an object.

4. The Electron: Self-Trapping Rotation

The electron is photon energy rotated off the 45° null line into 3D space. The specific direction of this rotation causes the wave to **self-trap**: it closes on itself into a toroidal standing wave that is locked in 3D space.

Premise. A photon on the 45° null line propagates freely. Rotating the wave off the null line breaks the time-space balance. For the electron, the rotation winds the wave into a closed toroidal loop — the wave circulates rather than propagates.

Consequence. A closed, circulating standing wave is locked in 3D space. It does not propagate away. Its trapped wave energy is, by Axiom A4, its rest mass:

$$m_e c^2 = (\text{trapped standing-wave energy of the electron})$$

Result. The electron always has rest mass m_e. The self-trapping is intrinsic to the electron's rotation direction; the electron cannot un-trap. It is permanently a localized standing wave. Because it is trapped — locked in 3D space — it must continuously convert local time to local space to persist, and therefore it gravitates with gravitational mass m_e (companion paper FGW_electron, Section 14).

5. The Positron: The Twisted Photon

The positron is the same photon energy rotated off the 45° null line, but with the **opposite twist**. This single difference — the handedness of the rotation — produces a completely different object.

5.1 The opposite-twist rotation does not self-trap

Premise. The electron's rotation winds the wave into a closed, self-trapping toroidal loop. The positron's opposite-twist rotation winds the wave the other way. The opposite winding does not close on itself for self-confinement: its flux is twisted into the 3D space domain rather than into the closed time-domain loop.

Consequence. Because the positron's flux is in the space domain, it sees normal (time-domain) flux as a barrier — it cannot wind into the configuration that self-traps. The positron therefore does not self-trap. It is not locked in 3D space.

Result. A free positron does not form a standing wave. It **walks freely** — it propagates like an electromagnetic wave. It is, structurally, a **twisted photon**: photon energy carrying the opposite-twist rotation, propagating rather than trapped.

5.2 The free positron is massless

By Axiom A4, rest mass *is* trapped standing-wave energy. A free positron is not trapped — it propagates. Therefore a free positron has **zero rest mass**:

$$\text{free positron:} \quad m = 0 \quad \text{(a twisted photon, walks at wave speed)}$$

The free positron still carries energy — it is photon energy, after all — but that energy is propagating wave energy, not trapped standing-wave energy. It has no rest mass because it has no standing-wave trap.

5.3 The trapped positron has mass m_e

The positron cannot self-trap, but it **can** be trapped externally. When another particle's flux holds the positron in 3D space — an electron's flux in positronium, gluon dragging inside a quark, or the ambient electron flux of a matter environment — the positron becomes a localized standing configuration. By Axiom A4, the externally-trapped positron then has rest mass:

$$\text{trapped positron:} \quad m = m_e$$

The positron's mass is context-dependent. Free: m = 0 (twisted photon). Trapped: $m = m_e$. The electron's mass is intrinsic (it self-traps and is always massive); the positron's mass is conferred by external trapping. This asymmetry — electron self-traps, positron only externally traps — is the deep electron/positron, matter/antimatter asymmetry. In every laboratory situation the positron is in some flux environment (matter, magnetic traps), so it is always observed with mass m_e; the massless free positron is the idealized true-vacuum limit.

6. Energy Conservation: Always Electromagnetic-Wave Energy

There is no energy-conservation difficulty anywhere in this picture, because every object discussed — photon, electron, free positron, trapped positron — is the same thing: electromagnetic-wave energy. Energy is simply moved between forms:

Form	Description	Rest mass
Photon	EM wave on the 45° null line, propagating	0
Free positron	Twisted photon, opposite-twist EM wave, propagating	0
Trapped positron	Externally trapped standing configuration	m_e
Electron	Self-trapped toroidal standing wave	m_e

Pair production ($\gamma\gamma \rightarrow e^- + e^+$): two photons of total energy $2m_ec^2$ become one electron (self-trapped, rest mass m_e) and one positron (twisted photon if free, carrying energy m_ec^2; or trapped, rest mass m_e, if the environment holds it). Total energy is conserved exactly.

Annihilation ($e^- + e^+ \rightarrow \gamma\gamma$): the electron's trapped standing wave and the positron release as two photons of total energy $2m_ec^2$. Total energy conserved exactly. Energy is conserved at every step because it is always electromagnetic-wave energy — only its form (propagating vs. trapped) changes.

7. Gravity as the Conservation of Energy

Gravity in the framework is the bookkeeping of mass converting local time into local space (Section 3). It is sourced by **rest mass** — self-trapped standing-wave configurations that must make room to persist — not by total energy.

Object	Trapped?	Converts time→space?	Sources gravity?
Electron	Self-trapped	Yes (must make room)	Yes, m_e
Free positron	Not trapped	No (walks freely)	No
Trapped positron	Externally trapped	Yes (held in place)	Yes, m_e
Photon	Not trapped	No (propagates at c)	No

A free positron and a photon both carry energy and both **respond** to gravity — the H field bends and redshifts them — but neither **sources** gravity, because neither is trapped, and an untrapped wave does not need to convert time to space to persist. It simply propagates.

Why there is no conservation problem. Energy is conserved always (it is all EM-wave energy). Gravity is sourced by the rest-mass subset — the trapped standing-wave configurations. When trapped energy converts to radiation (annihilation), the rest mass genuinely goes to zero and the gravitational sourcing correspondingly decreases. This is not a violation: gravity was never a quantity tracking total energy. It tracks rest mass — the configurations that must make room to exist. This is the framework's one definite departure from general relativity: **radiation does not source gravity**; only rest mass does. For ordinary matter, where rest mass dominates, the two agree; the difference is a falsifiable prediction (a sealed box of light would weigh less than the equivalent rest mass).

8. Positronium: Approach and Trapping

Positronium is the bound state of an electron and a positron. In the framework it is the clearest example of a positron being trapped externally and thereby acquiring mass.

Approach. A free positron (a twisted photon) approaches an electron. The electron is a self-trapped standing wave with time-domain flux. The positron's space-domain flux sees the electron's time-domain flux as a barrier — it cannot simply merge.

Trapping. Instead of merging, the positron is captured into orbit by the electron's flux. The electron's flux now holds the positron in 3D space. The positron becomes a localized standing configuration — it is trapped. By Axiom A4 it acquires rest mass m_e.

The bound state. Positronium is the electron (self-trapped, m_e) plus the positron (now externally trapped, m_e), orbiting their common center, bound by their mutual electromagnetic attraction:

$$m_{\text{positronium}} = m_e + m_e = 2m_e$$

Result. Positronium has rest mass $2m_e$. Both particles are now trapped, both gravitate, and positronium has gravitational mass equal to its inertial mass $2m_e$ — it falls normally under gravity, in agreement with the equivalence principle. The positron's mass and gravity here are conferred by the trapping; a free positron would have neither.

The binding energy of positronium is, by the framework's atomic-physics derivation (reduced-mass Rydberg, with the reduced mass $m_e/2$):

$$E_{\text{bind}} = \frac{1}{2} \cdot \frac{1}{2}\alpha^2 m_e c^2 = \frac{\alpha^2 m_e c^2}{4} \approx 6.8 \text{ eV}$$

This is half the hydrogen Rydberg energy, because the reduced mass of two equal masses is $m_e/2$ rather than approximately m_e.

9. Positronium: Wrapping, Syncing, and Decay

Positronium is not permanently stable. The electron and positron eventually **sync** — their windings align — and the two standing-wave traps release together as photons. The decay rate depends on how readily the two windings can sync, which depends on their relative spin orientation.

9.1 Para-positronium (anti-parallel windings)

When the electron and positron windings are anti-parallel (singlet state, total spin 0), the two windings can wrap and sync directly: each cancels the other's winding. The release is fast and produces **two photons**:

Property	Para-positronium
Winding configuration	Anti-parallel (singlet, S = 0)
Sync	Direct — windings cancel pairwise
Decay channel	2 photons

Mean lifetime	0.125 ns (1.25×10^{-10} s)

9.2 Ortho-positronium (parallel windings)

When the windings are parallel (triplet state, total spin 1), they cannot sync by direct pairwise cancellation — a parallel pair cannot wrap into two photons while conserving the winding angular momentum. The system must instead release through a three-photon channel, which requires an additional winding rearrangement and is far slower:

Property	Ortho-positronium
Winding configuration	Parallel (triplet, S = 1)
Sync	Indirect — requires three-photon rearrangement
Decay channel	3 photons
Mean lifetime	142 ns (1.42×10^{-7} s)

The lifetime ratio ortho/para is approximately 1120 — ortho-positronium lives roughly a thousand times longer. In the framework this is the difference between direct pairwise winding-sync (fast, 2-photon) and the indirect three-photon rearrangement (slow). The decay is the positron and electron syncing their windings and releasing their trapped energy back into propagating photon form — trapped energy returning to free EM-wave energy, with total energy $2m_ec^2$ conserved exactly.

10. Positronium: Laboratory Tests of Trapping

The framework's claim — that a positron's lifetime depends on how it is trapped by surrounding electron flux — is directly tested by positron annihilation lifetime spectroscopy (PALS), a standard materials-science technique.

In PALS, positrons are injected into a material and their lifetimes measured. The positron lifetime depends on the local electron density — on how tightly the positron is held by the surrounding electron flux:

Environment	Electron flux density	Positron lifetime
Dense metal (bulk)	High	~0.1–0.2 ns (fast trapping & sync)
Vacancy / defect	Reduced	~0.2–0.5 ns (looser trapping)
Large void / pore	Low	~1–100+ ns (weak trapping, ortho-Ps forms)

The framework reading: the more tightly the surrounding electrons hold (trap) the positron, the faster it finds an electron to sync with and annihilate. In a dense metal, the positron is held tightly amid high electron flux and annihilates quickly. In a void or pore, the positron is loosely trapped, forms ortho-positronium, and lives much longer. PALS thus directly measures the framework's central positron claim — that the positron is trapped externally by electron flux, with trapping strength setting the lifetime. This is a routine, reproducible laboratory confirmation of the trapped-positron picture.

11. Quarks: Cone-Trapped Positrons

Inside a baryon, positrons are trapped in a third way: not by an electron's flux (positronium) but by the gluon standing wave of the three-mirror baryon structure. A trapped positron held at a precession cone is an **up quark**.

The up quark is a positron, externally trapped (hence rest mass), precessing on a cone. The cone precession is driven by the gluon standing-wave dynamo (Section 14). All up-type quarks (u, c, t) share the same cone angle; they differ only in the Lorentz factor of the precession, which sets the generation mass.

12. The Cone Angle: Explicit Derivation

We derive the up-quark cone angle from charge balance. The derivation uses only the proton's structure and its net charge.

12.1 The proton's particle content

The proton is the unique stable three-mirror baryon: three quark vertices arranged on a planar equilateral triangle. Its composition (uud) in framework terms:

Vertex	Particle	Type
Up quark 1	Positron (cone-trapped, precessing)	spinning positron
Up quark 2	Positron (cone-trapped, precessing)	spinning positron
Down quark	Up quark + one bound electron	positron + bound electron

So the proton contains **3 positrons + 1 bound electron**: one positron in each of the two up quarks, plus one positron and one bound electron making the down quark.

12.2 The charge-balance equation

Premise 1. The electron has charge −1 (one inward topological winding). The positron has charge +1 (one outward winding). These are framework primitives.

Premise 2. The proton must bind exactly one electron to form the neutral hydrogen atom — the simplest stable neutral matter. Therefore the proton has net charge +1.

Premise 3. Each of the 3 positrons in the proton precesses on a cone of half-angle θ. The cone precession reduces the time-averaged charge measured along the lab axis from the full value +1 to a projected value (Section 13 derives this projection as cosθ). The bound electron contributes its full charge −1.

Charge balance. The proton's net charge is the sum of the three cone-projected positron charges plus the bound electron:

$$Q_{\text{proton}} = 3\cos\theta - 1 = +1$$

Solve. Rearranging:

$$3\cos\theta = 2 \quad \Rightarrow \quad \cos\theta = \frac{2}{3}$$

$$\theta = \arccos\left(\frac{2}{3}\right) = 48.1897^\circ$$

Result. The up-quark cone half-angle is θ = arccos(2/3) = 48.19°, **derived** from charge balance: three cone-precessing positrons plus one bound electron must sum to the proton's net charge +1. The value 2/3 is not assumed from the measured up-quark charge; it is forced by 3cosθ − 1 = 1. The measured up-quark charge +2/3 is then a **consequence**: it is the cone projection cos(48.19°) = 2/3.

13. The Charge-Projection Integral

We now show explicitly that a charge precessing on a cone has time-averaged projection cosθ — the "charge spread" mechanism. This is elementary precession geometry, derived here in full.

Setup. A positron of full charge q = +1 precesses on a cone of half-angle θ about the cone axis (which points toward the proton's center). At any instant, the charge vector makes angle θ with the cone axis. As it precesses, the azimuthal angle φ sweeps from 0 to 2π at the precession rate.

Decompose. Resolve the charge vector into a component along the cone axis and a component perpendicular to it:

$$q_{\parallel} = q\cos\theta \quad (\text{constant}), \qquad q_{\perp}(\phi) = q\sin\theta\,(\cos\phi,\, \sin\phi)$$

Time-average. The measured charge along the lab axis is the time-average over one precession period T. The parallel component is constant; the perpendicular component rotates and averages to zero:

$$\langle q_{\parallel} \rangle = \tfrac{1}{T}\int_0^T q\cos\theta\; dt = q\cos\theta$$

$$\langle q_{\perp} \rangle = \tfrac{q\sin\theta}{2\pi}\int_0^{2\pi} (\cos\phi,\, \sin\phi)\; d\phi = (0,\, 0)$$

Result. The measured (time-averaged) charge of a cone-precessing positron is exactly ⟨q⟩ = q·cosθ. The perpendicular component — the "charge spread" around the cone — averages to zero. For the up quark, q = +1 and cosθ = 2/3, giving measured charge +2/3. The fractional charge of the quark is the cone projection of a full unit charge; it is not a fundamental fractional charge.

14. The Down Quark

The down quark is the up quark with one additional bound electron. It is a tilt-stabilized positronium — a positron and an electron held together, but with the positron at the up-quark cone so the geometry blocks the direct winding-sync that would annihilate ordinary positronium.

Composition. Down quark = (up quark) + (one bound electron) = (cone-trapped positron at 48.19°) + (bound electron).

Charge. The up-quark part contributes the cone-projected charge +2/3. The bound electron contributes its full charge −1. The down quark's net charge is their sum:

$$Q_{\text{down}} = +\tfrac{2}{3} + (-1) = -\tfrac{1}{3}$$

> **Result.** The down quark has charge −1/3, derived by arithmetic: the up-quark cone projection +2/3 minus the bound electron's −1. **The down quark has no separate cone angle.** Its physical structure is the up-quark positron at the single derived cone of 48.19° plus a bound electron. The number arccos(1/3) = 70.53° is merely the arccosine of the down quark's charge magnitude; it is a bookkeeping label, not a physical precession angle. The framework has exactly one physical quark cone: 48.19°.

Why the down quark does not annihilate: ordinary positronium annihilates when its windings sync. In the down quark the positron is held at the 48.19° cone, and the cone-tilt geometry prevents the direct winding-sync that 2-photon annihilation requires. The down quark is a tilt-stabilized electron-positron pair — the same two particles as positronium, in a geometric configuration that blocks annihilation.

15. The Gluon Standing-Wave Dynamo

We now explain what holds the positrons trapped inside the proton, what drives their cone precession, and how this confers gravity on the bound positrons.

15.1 The three-vertex standing wave

The proton's three quark vertices are connected by a standing wave. The wave content emitted by each vertex propagates inward at wave speed c and meets at the geometric center, where the three contributions constructively interfere. This central interference point is where the proton converts time-stream energy into outgoing space-stream (gravitational) shells. The standing wave between the vertices is the gluon field; it carries approximately 99% of the proton's mass-energy.

15.2 Time-dragging: the dynamo

The gluon standing wave acts as a **dynamo**. The central interference point pulls wave content inward continuously; this pulls each quark vertex forward in time. The quarks are dragged through time by the gluon standing wave.

The drag. A free positron walks freely — nothing drags it, it does not convert time to space, it has no mass and no gravity. A positron at a proton vertex is gripped by the gluon standing wave and dragged forward in time along with the whole proton.

The response. A positron being dragged forward in time, while held at a vertex, responds by precessing. The drag cannot move the trapped positron away (it is held by the gluon wave), so the positron's response to being pulled is rotational: it precesses on a cone. The cone precession is the dynamo's rotor — the positron spinning in response to the time-drag, exactly as a flywheel spins when torqued.

Result. The gluon standing wave is the dynamo's drive; the cone-precessing positrons are its rotors. The drag forces each vertex positron into the cone-precession configuration at the geometrically-required angle 48.19°. The positrons are now **trapped** (held by the gluon wave) and **dragged through time** (forced to convert time to space).

15.3 Why the bound positrons gravitate

A free positron has no mass and no gravity because it is not trapped and does not convert time to space. A positron inside the proton is trapped by the gluon standing wave and dragged through time. Being dragged through time **is** converting local time into local space — which is gravity (Section 3). Therefore the bound positrons in the proton gravitate, with rest mass m_e each, exactly like trapped positrons in positronium.

The positron's gravity is conferred by trapping and dragging. Free: no trap, no drag, no mass, no gravity (twisted photon). In positronium: trapped by the electron's flux — mass m_e, gravitates. In a quark: trapped and time-dragged by the gluon dynamo — mass m_e, gravitates, and precesses on the 48.19° cone. The same positron, three contexts, three behaviors, one consistent rule: trapped and converting time to space ⇒ mass and gravity; free ⇒ neither.

16. The Proton and the Neutron

The proton (uud) and neutron (udd) are now fully specified in framework terms.

Baryon	Quarks	Particle content	Net charge
Proton	u u d	3 positrons + 1 bound electron	3(+2/3) − 1 = +1
Neutron	u d d	3 positrons + 2 bound electrons	3(+2/3) − 2 = 0

The neutron has one more bound electron than the proton (it has two down quarks, each carrying a bound electron). The neutron-proton mass difference follows from the extra down-quark content offset by the proton's electromagnetic self-energy; the framework derivation (companion paper FGW_particles) gives $m_n - m_p = 1.30$ MeV against the measured 1.293 MeV.

All particles in the proton — the 3 positrons and the 1 bound electron — are trapped and time-dragged by the gluon dynamo, so all contribute to the proton's rest mass and gravity. The proton gravitates with its full mass m_p, of which approximately 99% is the gluon standing-wave energy and approximately 1% is the constituent particle content.

17. CP Violation: The Consequence of Monodirectional Time

CP violation in quark mixing is conventionally treated as a separate phenomenon requiring its own free parameter — the CKM phase δ_{CP}. In the framework, CP violation requires no parameter at all. It is the automatic consequence of monodirectional time (Axiom A2).

17.1 Why the Standard Model needs a CP phase

The Standard Model writes its microscopic equations to be time-reversal (T) symmetric. CP violation is then observed; by the CPT theorem, observed CP violation forces T violation. To account for this, the CKM matrix is given a complex phase δ_{CP} — a free parameter that exists solely because the equations were written T-symmetric and then had to be patched to match a universe that is not.

17.2 The framework has no T-symmetry to break

Axiom A2: time is monodirectional. The substrate's forward-time direction is selected by the outgoing-wave-shell solutions at central interference points. There is no T-symmetric version of the framework's equations — T is not a small broken symmetry but is absent as a symmetry from the start.

CPT logic. The substrate is CPT-invariant: charge-conjugating, parity-flipping, and time-reversing all together recovers the dynamics. C and P are individually good symmetries. But T is broken at the axiom level. By CPT invariance:

$$\mathrm{CP} = \mathrm{CPT} \times \mathrm{T}^{-1}$$

Conclusion. If CPT is exact and T is broken, then CP is broken — automatically, with no mechanism, no parameter, no fine-tuning. CP violation is the necessary shadow of monodirectional time.

Result. The framework has **no δ_{CP} free parameter**. The Standard Model needs four CKM parameters (three mixing angles plus one CP phase); the framework needs three (the mixing angles only). The CP phase was never a physical degree of freedom — it was bookkeeping for the gap between T-symmetric equations and a forward-time universe. Write the equations forward-time-only and the parameter vanishes.

17.3 The Jarlskog invariant

CP violation is "fully on" — the forward-time asymmetry is total — but it is only observable through quark flavor mixing, which is suppressed by the small CKM mixing magnitudes. The Jarlskog invariant therefore has no free phase factor:

$$J = |V_{us} \cdot V_{cb} \cdot V_{ub} \cdot V_{cs}|$$

With measured CKM magnitudes ($|V_{us}| = 0.22431$, $|V_{cb}| = 0.04090$, $|V_{ub}| = 0.00382$, $|V_{cs}| = 0.97349$):

$$J = 3.41 \times 10^{-5}$$

Result. Measured J = (3.08 ± 0.14) × 10^{-5}. Framework match: ~10%, with the residual lying entirely in the CKM mixing magnitudes (the V_{cb} estimate is the known rough spot in the quark-mixing sector), not in any CP phase — there is no CP phase left to be rough. CP violation is maximal because time is maximally one-directional, and J is simply the CKM mixing-magnitude product.

18. R_∞ as the Time-to-Space Conversion Rate

The Rydberg constant R_∞ — conventionally an empirical anchor — has a direct physical meaning in the framework. It is the rate at which the proton converts local time into local space, per proton Compton cycle, observed at the atomic scale.

The proton's three-mirror standing wave (the gluon dynamo) cycles at the proton Compton frequency $f_C^p = m_p c^2/h$. Each cycle, the central interference point converts a quantum of time-stream into outgoing space-stream — this is the proton making room to exist (Section 3). The Rydberg constant is this conversion rate as it appears at the atomic scale, related to the proton's primary frequency by a pure-geometric factor:

$$\frac{f_C^p}{c\,R_\infty} = \frac{12\,\pi^5}{\alpha^2}$$

Solving for R_∞:

$$R_\infty = \frac{f_C^p\,\alpha^2}{12\,\pi^5\,c} = \frac{m_p c\,\alpha^2}{12\,\pi^5\,h}$$

Result. R_∞ is a reflection of the gluon standing-wave energy. It carries the proton mass-energy $m_p c^2$ (which is approximately 99% gluon standing-wave energy), scaled by $\alpha^2/(12\pi^5)$ to bring it to the atomic scale. When we measure the Rydberg constant by atomic spectroscopy, we are measuring the proton's time-to-space conversion rate — the rate at which the proton's gluon dynamo makes room for the proton to exist.

18.1 The framework's unit choices

The framework needs only conventional unit choices to connect its geometry to measured numbers: c is meters per second (a unit-system convention), and the electron charge is −1 (the framework's charge primitive). Everything else — mass, the H field, gravity, the cone angles, the Rydberg constant — is a consequence of mass needing space to exist in, and to move through, the present instant. There are no free physical parameters; only the unit conventions and the requirement that mass make room.

19. Comprehensive Results

Quantity	Framework	Measured / Observed	Status
POSITRON			
Free positron rest mass	0 (twisted photon)	untested (positrons annihilate fast)	prediction
Trapped positron rest mass	m_e	0.511 MeV (always, in flux)	consistent
Free positron gravity	none	untested	prediction
POSITRONIUM			
Positronium rest mass	2 m_e	1.022 MeV	consistent
Binding energy	alpha^2 m_e c^2 / 4 = 6.8 eV	6.8 eV	match
Para-Ps lifetime	fast 2-photon sync	0.125 ns	consistent
Ortho-Ps lifetime	slow 3-photon sync	142 ns	consistent
PALS lifetime vs electron density	tighter trap = faster	observed	confirmed
QUARKS			
Up quark cone angle	arccos(2/3) = 48.19 deg	(derived)	derived
Up quark charge	+2/3 (cone projection)	+2/3	derived
Down quark charge	+2/3 - 1 = -1/3	-1/3	derived
Physical quark cones	one: 48.19 deg	(70.53 deg is not physical)	corrected
BARYONS			
Proton charge	3(+2/3) - 1 = +1	+1	derived
Neutron charge	3(+2/3) - 2 = 0	0	derived
CP VIOLATION			
CKM free parameters	3 (no CP phase)	SM uses 4	parameter removed
Jarlskog J	|V_us V_cb V_ub V_cs| = 3.41e-5	3.08e-5	10%
RYDBERG			
R_infinity meaning	time-to-space conversion rate	(empirical anchor)	interpreted

20. Falsifiable Predictions

• **Free positron is massless.** A positron held in true vacuum, isolated from all matter and field flux long enough to measure, would show zero rest mass and propagate at wave speed. (Currently untestable — positrons annihilate before isolation is achieved.)

• **Free positron has no gravity.** A genuinely free positron neither sources nor responds to gravity as a massive particle would. (Untestable with current technology.)

• **Radiation does not source gravity.** A sealed box of light weighs less than the equivalent rest mass — gravity tracks rest mass, not total energy. (Falsifiable in principle.)

• **Positronium falls normally at g.** Both particles are trapped, both gravitate; positronium has gravitational mass equal to inertial mass $2m_e$.

• **PALS lifetime tracks trapping strength.** Positron lifetime in matter scales inversely with how tightly surrounding electron flux holds it — already confirmed by materials science.

• **One physical quark cone.** All quark structure uses the single derived cone 48.19°; 70.53° never appears as a physical angle. Any framework formula genuinely requiring 70.53° as a precession angle would falsify this.

• **CP violation needs no free phase.** $J = |V_{us}V_{cb}V_{ub}V_{cs}|$ with no δ_{CP}; the residual gap closes as the V_{cb} magnitude is refined.

21. Conclusion

The positron, positronium, and quarks have been derived from the framework's axioms with every step shown. The central results:

• The positron is photon energy rotated off the 45° null line with the **opposite twist** to the electron. The opposite twist does not self-trap.

• A **free positron is a twisted photon**: massless, walking freely, no gravity. It is not trapped, does not convert time to space, and therefore needs neither mass nor gravity.

• A **trapped positron has mass m_e**: held by an electron's flux (positronium), by the gluon dynamo (a quark), or by a matter environment, it becomes a localized standing configuration and acquires rest mass and gravity.

• **Energy is always conserved** — it is always electromagnetic-wave energy, propagating or trapped. There is no conservation difficulty anywhere.

• **Gravity is the bookkeeping of mass converting local time into local space —** the H field. It is sourced by rest mass (trapped configurations), not total energy.

• **Positronium** is the electron and trapped positron bound; it decays when their windings sync — fast 2-photon for anti-parallel (para), slow 3-photon for parallel (ortho). PALS confirms the trapping picture in the laboratory.

• The **up-quark cone angle 48.19°** is derived from charge balance: three cone-precessing positrons plus one bound electron sum to the proton charge +1, forcing $\cos\theta = 2/3$.

• The **charge-projection integral** shows the measured fractional quark charge is the cone projection $q\cdot\cos\theta$ of a full unit charge.

• The **down quark** is up-plus-bound-electron with charge $+2/3 - 1 = -1/3$, derived by arithmetic. There is one physical quark cone; 70.53° is not a physical angle.

• The **gluon standing-wave dynamo** drags the quarks through time, forcing the cone precession and conferring rest mass and gravity on the bound positrons.

• **CP violation** requires no free parameter: it is the automatic consequence of monodirectional time. The framework removes the Standard Model's δ_{CP}.

• $\mathbf{R}_\infty$ is the proton's time-to-space conversion rate per Compton cycle, reflecting the gluon standing-wave energy.

Everything follows from one principle: mass exists only in the present, and mass needs space to exist in and to move through. The electron self-traps and pays for its existence with gravity. The positron, oppositely twisted, does not self-trap — free, it is a twisted photon that simply walks; trapped, it joins the electron in paying for existence. The quarks are positrons trapped and dragged by the gluon dynamo. We use c as meters per second and the electron charge as −1; everything else is a consequence of mass needing space to exist or to move through time.

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Companion papers: "The Electron" (FGW_electron) — the electron's complete structural derivation; "Fundamental Gravitational Waves and Particles" (FGW_particles) — the full particle spectrum; "Fundamental Gravitational Waves: A Theory of Everything" (FGW_TOE) — the unified framework.