

Quantum G Theory: Unification of Gravity and the SM via Torsion in G_2 Holonomy

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Abstract

Quantum G Theory (QGT) extends M-theory on the G_2 -holonomy Joyce orbifold $T^7/(\mathbb{Z}_2)^3$, with E_8 unfolding and self-dual Kalb–Ramond (KR) torsion. A high-energy frequency field reproduces the SM masses via membrane instantons and derives the cosmological constant Λ , the vacuum density ρ_Λ and the dark-matter and dark-energy Ω densities from the frequencies f_g and f_Λ , yielding both ranges of the Hubble tension with the exact ratio $27/8\pi$. Fundamental constants are reproduced to high precision (G_N to 0.07%; $\alpha = 1/137.036$), and the chain $\text{EH} = 2g_s$, $\mathcal{K}_\beta = 16\pi/3$ proves equivalent to $V_g = 2c$. Since $\rho_{\text{QGT}}/\rho_\Lambda = 1$, the hierarchy $f_p^5 = f_\Lambda^2 f_g^3 \times 10^{123}$ removes fine tuning; $\text{KR} = \text{ER} = \text{EPR}$ anchors entanglement in the two-sheeted torsional geometry. The volume-modulus reduction derives $g_s = 2(d-1)/(d+2)|_{d=7} = 4/3$, making $m = \tau_0/3$ and $|\Lambda_4| = g_s \tau_0^2$ theorems, and proves $V_{\min} < 0$ at every critical point: the $AdS_4 \rightarrow dS_4$ uplift is excluded from the classical sector and bounded to a finite computation.

Keywords: M-theory; G_2 holonomy; flux compactification; Kalb–Ramond torsion; reproduction of cosmological constants; AdS/CFT correspondence; reproduction of fundamental constants and SM masses.

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Introduction

The unification of quantum gravity with the gauge interactions of the Standard Model (SM) and the resolution of the scale-hierarchy problem [1, 2] constitute two of the central challenges of contemporary theoretical physics. Quantum G Theory (QGT) addresses both through the compactification of eleven-dimensional supergravity [3] on manifolds of G_2 holonomy, with the quantum torsion H_3 of the Kalb–Ramond field as the central geometric ingredient. The present work synthesizes in seven sections the results developed in the original monograph of the theory [4] and in the associated graduate thesis [5], whose intellectual property was registered in 2020.¹

The QGT approach reformulates the internal geometry and its dynamics in terms of a minimal set of frequency parameters: two high-energy frequencies—the critical graviton frequency f_g and the Planck frequency f_p , both of supra-Planckian scale, $\sim 10^{19}$ GeV—and the cosmological frequency f_Λ , together with the graviton wavelength $\ell_g = R_{11} = c/f_g$ as the compactification scale of the eleventh dimension. From these parameters one obtains a unified reformulation of the Einstein, Schwarzschild, Friedmann and Maxwell equations, integrated with the Schrödinger equation through Bekenstein–Hawking-type entropic connections and the AdS/CFT correspondence [1, 6].

The empirical test of the framework rests on the reproduction, from first principles, of a broad set of fundamental constants: atomic constants (R_∞, a_0, μ_B), SM particle parameters, cosmological constants ($\Lambda, \rho_\Lambda, H_0$) and fractional densities ($\Omega_\Lambda, \Omega_{\text{dm}}, \Omega_b$). This synthesis correlates traditionally disconnected physical domains and places the fundamental high-energy frequencies as bridges between the geometry of the extra dimensions and the phenomenology of the observable universe [5].

A distinctive element of the model is the conjecture $\text{KR} = \text{ER} = \text{EPR}$, which extends the $\text{ER} = \text{EPR}$ correspondence of Maldacena and Susskind [6, 7]—in a conjecture proposed in this work—by incorporating the Kalb–Ramond torsion as the geometric origin of quantum entanglement. This conjecture is implemented through a torsion metric of hypertoroidal-wormhole type [4, 5] (Section 5) and connects, in the AdS_4 vacuum of the theory, with the cosmological-constant problem.

The manuscript deliberately preserves an explicit *epistemic framing*: in each section, established results are distinguished from genuinely open problems, and the reproductions of constants are presented as consistent effective parametrizations rather than closed predictions whenever their first-principles derivation remains incomplete. This distinction is essential to situate honestly the scope of the theory with respect to the standard literature on G_2 compactifications of M-theory [8, 9].

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The structure of the paper is as follows. Section 1 establishes the reproduction of the universal SM constants from the frequency system. Section 2 specifies in detail the geometric compactification: the G_2 manifold, the torsion class, the flux type and the four-dimensional effective action. Section 3 develops the cosmological constants and the vacuum energy density. Section 4 addresses the quantum-relativistic unification and the quantization of the Schwarzschild metric. Section 5 formulates the conjecture $KR = ER = EPR$ and the hypertoroidal structure. Section 6 deals with the torsional velocity $V_g = 2c$ and the matter/antimatter symmetry. Finally, Section 7 explores the dualities among quantum mechanics, electromagnetism and the AdS/CFT correspondence, in dialogue with principles of ancient philosophy.

This work is organized as follows. Section 1 establishes the frequency interaction system and reproduces the universal constants and the SM masses, with G_N obtained along three independent routes, $\alpha = 1/137.036$ and the exact chain $EH = 2g_s$, $\mathcal{K}_\beta = 2\pi EH = 16\pi/3$, equivalent to $V_g = 2c$. Section 2 constructs the generalized action on the G_2 -holonomy Joyce orbifold $T^7/(\mathbb{Z}_2)^3$ with E_8 unfolding, fixes the Kalb–Ramond torsion in the Fernández–Gray class $\mathcal{W}_1 \oplus \mathcal{W}_4$ with an Englert flux at its self-dual point, and derives the four-dimensional effective action together with its limitations. Section 3 adapts the Friedmann equation to the frequency framework and obtains Λ , the Ω densities as rationals of the model and both ranges of the Hubble tension, tied by the relation $9z = 27/8\pi$. Section 4 formulates the quantum-relativistic field equations, the quantization of the Schwarzschild metric and the constant $\mathcal{K}_\beta$. Section 5 develops the two-sheeted hypertoric structure and its link with the G_2 manifold, where entanglement is interpreted as vacuum geometry through the conjecture $KR = ER = EPR$. Section 6 derives the torsional velocity $V_g = 2c$ from the matter/antimatter dynamics modelled as open strings in a Kaluza–Klein cylinder. Section 7 declares the heuristic origin of the model—the cone of seven frequencies—and collects in Table 10 the parametric QM/EM equations and, in Figure 11, the localization of the three branes on the two-sheeted vacuum. The technical appendix, distributed as Supplementary Material, develops in full the geometry, the flux, the Gukov–Beasley–Witten reduction and the computational reproducibility of every identity reported here. The conclusions and the technical appendix—which gathers the formal proofs, the dimensional verification and the reproducibility module—close the work.

QGT Reproducibility Package. Every numbered identity, table and figure reported here is accompanied by an independent *QGT Reproducibility Package*: eleven Python/SymPy scripts that recompute the whole set of expressions from the declared input constants alone (CODATA 2022 [10], PDG 2024 [11], Planck 2018 [12]), a fixed-tolerance regression suite, a cross-reference auditor that checks every citation embedded in the code against an actual label of this manuscript, and a SHA-256 integrity manifest. The package runs in a few seconds with SymPy as its only dependency, and is documented in Section U of the Supplementary Material; it is archived at

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It certifies *computational* reproducibility—that each figure follows from the definitions the text declares—and is not a substitute for peer review of the physical foundations.

1 Unified Universal Constants in the SM

The Kalb–Ramond (KR) field is the antisymmetric tensor field $B_{\mu\nu}$ of string theory [13], which in M-theory [14] descends from the fundamental 3-form C_3 of eleven-dimensional supergravity [3] upon reduction on the circle S^1 ; its associated torsion $H_3 = dB$ distorts the space-time geometry and blurs the boundaries between gravity and electromagnetism (EM), as analysed by Edelman and Giribet [15]. It extends the electromagnetic potential A_μ to a higher-rank object, and in eleven-dimensional supergravity (11D SUGRA) it coexists with the 3-form $C_{\mu\nu\rho}$ that mediates the interactions of branes [3]. In QGT, the KR field unifies the “invisible” gravitational torsion with a rotating EM, manifesting as a quantum magnetic monopole $\bar{B}$ [4, 5].

Topologically, the KR torsion generates Einstein–Rosen (ER) bridges, which suggests extending the conjecture $ER = EPR$ [6, 7] to $KR = ER = EPR$: the torsion would mediate quantum entanglement (EPR) through nonlocal geometries [5]. This reading is consistent with p -brane democracy [16] and with the holographic framework, where the bulk fields—including $B_{\mu\nu}$ —correspond to operators of the boundary conformal field theory (CFT) [1].

Kaluza–Klein (KK) compactification unifies gravity and EM through an extra dimension [15]. On a torus T^7 , the reduction of 11D SUGRA yields $\mathcal{N} = 8$ supergravity in 4D; on a manifold of G_2 holonomy, by contrast, it preserves only $\mathcal{N} = 1$ [17–19]—the case relevant for QGT, developed in Section 2—. The Standard Model (SM) masses arise as kinetic energy along the compact directions: modes with nonzero momentum on a radius $\ll$ the atomic scale are perceived as massive particles, with $E \sim mc^2$ [5, 15].

Dualities connect apparently distinct descriptions. The AdS/CFT correspondence in its canonical form relates $\mathcal{N} = 4$ super Yang–Mills theory to the type IIB string on $AdS_5 \times S^5$ [1]; its M-theory realizations— $AdS_4 \times S^7$ and $AdS_7 \times S^4$ —fix M2- and M5-branes as electric and magnetic sources of the flux (Section 2). In this framework, an ultra-energetic collision ($\gg$ LHC) excites KK modes, and the dilaton radius R_g marks the passage to the non-perturbative regime. Figure 1 illustrates this mechanism: in the low-frequency perturbative regime the strings bounce off, whereas in the high-frequency non-perturbative regime they become trapped in counter-rotation along an extra dimension w [15]. This latter regime—where the KR–RR interaction produces centrifugal effects such as the G-force—constitutes the core of the present study [4, 5].

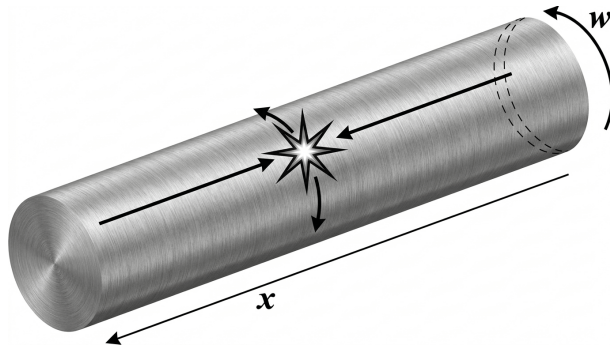


Figure 1: KK–RR interaction (Edelman–Giribet)[15].

1.1 Interaction System

Figure 2 illustrates a pair of D-branes interacting through the exchange of strings. The left side of Figure 2 shows how one D-brane exerts a force (attractive or repulsive) on the other D-brane through the exchange of a closed string or graviton propagating between the two D-branes. The right side of Figure 2 shows two open strings propagating around

an imaginary KK cylinder that the closed string had traced along its trajectory, moving in circles in opposite directions in w , as in Figure 1. Figure 2 reveals that the two descriptions are indistinguishable, being merely different ways of visualizing the same process. The mathematical results are identical according to the D-brane and RR-charge computations [20]. That is, exchanging a closed string such as a graviton between two D-branes is shown to be the same as sharing a pair of open strings between those same D-branes.

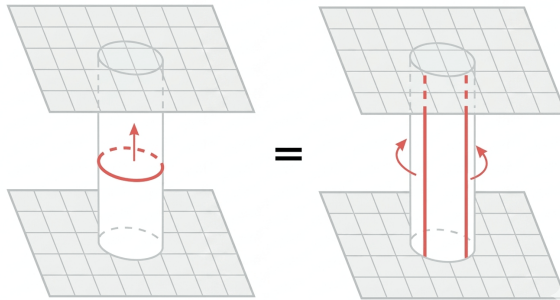


Figure 2: Polchinski's D-brane and RR interaction (Edelstein)[15].

In the context of closed-string collisions on the world sheet, these interactions can be assimilated to a quantum KR torsion field [13] akin to the KK mechanism [15], coupled to the EM field of supergravity [3], in synergy with the interaction of D-branes and RR charges [20, 21]. This suggestion raises a connection between open and closed strings and the fission or fusion of positive/negative energy according to the frequency level, respectively [4, 5, 13], and its relation to space-time torsion as a dynamical degree of freedom, systematically studied in the torsion-gravity literature [22, 23]. That is, depending on their frequency, the two open strings could be regarded as the fission of positive/negative energy, while the closed string would be the fusion of positive/negative energy, in the sense of the Breit–Wheeler process [24]; the philosophical reading of this fission/fusion as “principles of light” is developed in Section 7 [25]. These interactions act as Schrödinger standing waves and torsion waves in the quantum KR torsion field, generating the critical graviton frequency [4, 5].

Cylinder in Polchinski's Channel Duality: Here we represent the imaginary cylinder along which the strings propagate with a coordinate w parametrizing an imaginary dimension around the cylinder, with $R_g = c/(2\pi f)$, where R_g may be regarded as a fictitious radius of this imaginary cylinder. The propagation of open strings on this cylinder is reflected in terms of modes describing strings moving simultaneously clockwise and counterclockwise at the speed of light, which implies a relativistic velocity $V_g = 2c$. This equivalence reveals how the exchange of closed strings between D-branes can be reformulated as open strings propagating on the cylinder. Figure 2 displays dualities, the string tension being an interaction of positive/negative energy. The study of the interaction then focuses on the existence of the standing wave (as a loop) in Figure 3, when the wave number K , or the number of wavelengths fitting on the circumference, takes positive and negative values simultaneously; $\pm K$. All the figures being one and the same.

1.2 Polchinski's channel duality: parametric adaptation

This section —the core of the physical-mathematical infrastructure of the section— rewrites Polchinski's foundational computation [20] on D-branes and Ramond–Ramond (RR) charges in the frequency variables of QGT. The interaction system described in §1.1 —two counter-rotating open strings on a Kaluza–Klein cylinder, dual to the exchange of a closed string (the graviton) between two D-branes— is not a qualitative analogy: it is exactly the *channel duality* (*world-sheet duality*) of the one-loop vacuum amplitude, the

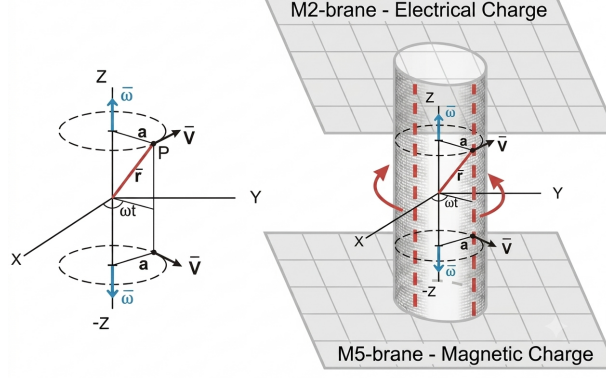


Figure 3: Superposed KR Torsion Field [4, 5].

computation that established that D-branes carry the totality of the RR charges with the minimal Dirac quantum. Rewriting it in QGT variables provides a precise diagrammatic foundation for three pillars of the model: the torsional velocity $V_g = 2c$, the critical graviton frequency f_g and the master mass pattern $m_i = m_g(f_i/f_g)$.

Epistemic note. The results of [20] are established physics, verified by three decades of literature. The frequency identifications that follow have the status of *consistent effective parametrizations* of the QGT framework, and are explicitly marked as Propositions, Lemmas and Identifications; the delimitation is consolidated in Table 4.

Boundary conditions, BPS state and cylinder amplitude

On the type II superstring one adds open strings with Neumann conditions on $p + 1$ coordinates and Dirichlet conditions on the remaining $9 - p$:

$$n^a \partial_a X^\mu = 0, \quad \mu = 0, \dots, p; \quad X^\mu = Y^\mu, \quad \mu = p + 1, \dots, 9, \quad (1)$$

so that the endpoints are confined to a $(p+1)$ -dimensional hyperplane: the Dp -brane. The world-sheet boundary reflects the right supercharges into the left ones, $Q_\alpha \rightarrow \bar{Q}_\alpha$; only one linear combination survives, the brane breaks half of the supersymmetries and is a BPS state [20]. For two parallel Dp -branes separated by a distance Y , the one-loop vacuum amplitude of the open strings stretched between them is, in Euclidean space-time,

$$\begin{aligned} \mathcal{A} = V_{p+1} \int_0^\infty \frac{dt}{t} (2\pi t)^{-(p+1)/2} e^{-tY^2/8\pi^2\alpha'^2} \prod_{n=1}^\infty (1 - q^{2n})^{-8} \times \frac{1}{2} \left[-16 \prod_{n=1}^\infty (1 + q^{2n})^8 \right. \\ \left. + q^{-1} \prod_{n=1}^\infty (1 + q^{2n-1})^8 - q^{-1} \prod_{n=1}^\infty (1 - q^{2n-1})^8 \right], \end{aligned} \quad (2)$$

with $q = e^{-t/4\alpha'}$. The sum in braces vanishes by Jacobi's “abstruse” identity: from the open channel it expresses the supersymmetry of the spectrum; from the closed channel, the absence of a net force between BPS states. Interchanging space and time on the world sheet ($t \rightarrow 0$ exposes the closed spectrum), the amplitude factorizes into the exchange of the NS–NS sector (graviton and dilaton, attractive) and the RR sector (repulsive):

$$\mathcal{A} = (1 - 1) V_{p+1} 2\pi (4\pi^2\alpha')^{3-p} G_{9-p}(Y^2), \quad G_{9-p}(Y^2) = \frac{1}{4}\pi^{(p-9)/2} \Gamma\left(\frac{7-p}{2}\right) (Y^2)^{(p-7)/2}, \quad (3)$$

where G_{9-p} is the transverse Green function and the factor $(1 - 1)$ records the exact NS–NS/RR cancellation: the signature of the BPS state.

QGT Identification 1.1 (Supercharge reflection and $\mathcal{N} = 1$ vacuum). The reflection $Q_\alpha \rightarrow \bar{Q}_\alpha$ induced by the world-sheet boundary in (1) is the perturbative analogue of the geometric projection that in QGT reduces $\mathcal{N} = 8$ (compactification on T^7) to $\mathcal{N} = 1$ (G_2 holonomy, §2.3): in both cases, half (or more) of the supersymmetries is eliminated by an identification condition —of boundary in Polchinski, of orbifold in QGT— and the resulting object is BPS. The involution $\mathbb{Z}_2$ that anchors the matter/antimatter symmetry (Section 6) plays the role of the boundary reflection.

Frequency Regge slope and string scale

Lemma 1.2 (Regge slope and string scale). *The QGT Regge slope (Table 2) is*

$$\alpha' = \frac{V_g^2}{8\pi f_g^2} = \frac{\ell_g^2}{2\pi}, \quad \ell_s \equiv \sqrt{2\pi\alpha'} = \ell_g = \frac{c}{f_g} = 4.9619 \times 10^{-35} \text{ m}, \quad (4)$$

with $[\alpha'] = \text{m}^2$: the string scale is anchored to the graviton wavelength and, with it, to the compactification scale $R_{11} = \ell_g$ of the eleventh dimension (§2.3).

Proof. With $V_g = 2c$, $V_g^2/(8\pi f_g^2) = c^2/(2\pi f_g^2) = \ell_g^2/2\pi$, which is manifestly an area, and $\ell_s = \sqrt{2\pi\alpha'} = \ell_g$ follows immediately. The useful identities also follow, $2\pi\alpha' = \ell_g^2$ and $4\pi^2\alpha' = 2\pi\ell_g^2$.

Channel duality as frequency inversion

With Lemma 1.2, the cylinder modulus is naturally made dimensionless,

$$x \equiv \frac{t}{4\alpha'} = \frac{\pi}{2} \frac{t}{\ell_g^2}, \quad q = e^{-x}. \quad (5)$$

Proposition 1.3 (Frequency inversion and self-dual point). *Define the effective channel frequency $f_{\text{can}}(x) \equiv f_g \sqrt{x/\pi}$. Then the modular transformation $x \rightarrow \pi^2/x$ that interchanges the open and closed channels of (2) is equivalent to the frequency inversion*

$$f_{\text{can}}(x) f_{\text{can}}\left(\frac{\pi^2}{x}\right) = f_g^2, \quad (6)$$

with a self-dual point of the world sheet at $x_* = \pi$, that is, at $f_{\text{can}} = f_g$.

Proof. Direct computation: $f_{\text{can}}(\pi^2/x) = f_g \sqrt{\pi^2/(\pi x)} = f_g \sqrt{\pi/x}$, whence

$$f_{\text{can}}(x) f_{\text{can}}(\pi^2/x) = f_g^2 \sqrt{(x/\pi)(\pi/x)} = f_g^2.$$

The fixed point $x_* = \pi$ gives $f_{\text{can}}(x_*) = f_g$.

Remark 1.4. Equation (6) gives precise mathematical content to the reading of Figure 1: the perturbative regime (strings that “bounce off”, open channel) and the non-perturbative regime (strings “trapped in counter-rotation”, closed channel dominated by the massless poles) are the two extremes of the *same* modular integral, related by the frequency inversion about f_g . This structure is the perturbative analogue of the self-dual point of the QGT Englert flux, $e/g_1 = 2/3$ (34), at which the electric (M2) and magnetic (M5) descriptions coincide: in both cases the resonance of the system lies at the graviton scale. The string T -duality, $R \rightarrow \alpha'/R$, adopts here the frequency form $f \rightarrow f_g^2/f$, with f_g as the fixed point.

$V_g = 2c$ as relative channel velocity

Proposition 1.5 (Torsional velocity from channel duality). *In the open channel, the cylinder traced by the exchanged closed string is traversed by two counter-rotating open modes, each at the limiting velocity c of its local light cone on the compact coordinate w :*

$$V_{e-} = +c, \quad V_{e+} = -c \quad \implies \quad V_g = c - (-c) = 2c. \quad (7)$$

Moreover, the relativistic balance of the vortex (Section 6, equation (91)),

$$(hf_g + m_g c^2)^2 = (m_g c^2)^2 + (Pc)^2 + \frac{1}{2} m_g V_g^2 hf_g, \quad Pc = hf_g, \quad m_g = \frac{hf_g}{c^2}, \quad (8)$$

has as its unique positive solution $V_g = 2c$.

Proof. Expanding the left-hand side of (8) and using $m_g c^2 = hf_g$: $(hf_g + m_g c^2)^2 - (m_g c^2)^2 - (Pc)^2 = 2hf_g m_g c^2 = 2(hf_g)^2$. The fluctuation term gives $\frac{1}{2} m_g V_g^2 hf_g = (hf_g)^2 V_g^2 / (2c^2)$. Equating both: $V_g^2 = 4c^2$, that is $V_g = 2c$ (positive root), consistent with (7). V_g is a relative velocity in the compact dimension w , not a signal velocity in 4D, so it does not conflict with special relativity.

Remark 1.6. In Polchinski’s dictionary, the left-hand side of (8) is the closed channel (*fusion*: a closed string of energy hf_g) and the right-hand side the open channel (*fission*: the counter-rotating pair); channel duality guarantees the equality of both descriptions and, with it, fixes V_g . The factor $(1 - 1)$ of (3) thus acquires an additional meaning: the NS–NS (attractive) and RR (repulsive) components are the two “polarities” whose exact cancellation defines the BPS state; QGT formulates it as the equilibrium of fusion/fission of positive/negative energy in the torsion vortex, and Jacobi’s abstruse identity is the mathematical expression of that equilibrium.

The stretched string and the master mass pattern

Proposition 1.7 (Brane-to-brane origin of the frequency spectrum). *The mass of the string stretched between the two branes of (2) is $m_Y = Y/(2\pi\alpha')$. With Lemma 1.2,*

$$m_Y = m_g \frac{Y}{\ell_g} = m_g \frac{f_Y}{f_g}, \quad f_Y \equiv f_g \frac{Y}{\ell_g}, \quad (9)$$

formally identical to the QGT master mass pattern, $m_i = m_g(f_i/f_g)$ (Table 3): the mass of a string stretched between D-branes separated by Y is the graviton mass multiplied by the separation measured in graviton wavelengths.

Proof. In natural units, $m_Y = Y/(2\pi\alpha') = Y/\ell_g^2 = (Y/\ell_g) \cdot (1/\ell_g)$. Restoring units, the mass associated with the scale $1/\ell_g$ is $m_g = hf_g/c^2$, whence (9). The ratio Y/ℓ_g is dimensionless, and $[m_Y] = [m_g] = \text{kg}$: the relation is homogeneous.

Remark 1.8 (Twofold reading: separation moduli and membrane instantons). In the geometric language of Section 2, the masses are generated by M2 membrane instantons wrapping associative 3-cycles Σ_i of the active locus, with $m_i = m_g \exp(-\text{Vol}(\Sigma_i)/\ell_{11}^3)$ [8, 26]. The correspondence between the two readings is

$$\frac{\text{Vol}(\Sigma_i)}{\ell_{11}^3} = \ln \frac{f_g}{f_i} = \ln \frac{\ell_g}{Y_i} \quad (Y_i < \ell_g) : \quad (10)$$

Polchinski’s brane-separation modulus and the QGT 3-cycle volume parametrize the *same* physical datum, the proper frequency f_i of the state. The volumes required for the SM fermions fall in the range 39–52 ℓ_{11}^3 (see the Discussion of this section and §2.3).

Epistemic delimitation. The pattern $m_i = m_g(f_i/f_g)$ is a *frequency reparametrization* of the Standard Model masses, not a derivation: since $f_i \equiv m_i c^2/h$ by definition, the ratio $m_i/m_j = f_i/f_j$ is an algebraic identity and carries no predictive content. Its physical content—if any—lies in the instantonic reading (10), whose actions fall in the range $39\text{--}52 \ell_{11}^3$: a non-trivial outcome, since actions $\lesssim 1$ would have been incompatible with the semiclassical expansion. Two further delimitations. First, the stretched-string reading (9) requires $Y \gtrsim \ell_s = \ell_g$, whereas the SM spectrum implies $Y_i/\ell_g \in [2 \times 10^{-23}, 7 \times 10^{-18}]$ —between 17 and 23 orders below the string scale—, so (9) is used as a formal parametrization and not as a dynamical derivation in that regime. Second, there is no evidence of a quantization of the volumes that would determine them. A lattice scan $\text{Vol}/\ell_{11}^3 \in \mathbb{Z}/q$ with $q \leq 48$ over the nine fermions gives as best fit $q = 37$ with maximum deviation 0.0094—equivalent to a 0.94% mass error—, while a control of 2000 random sets over the same range fits equally well or better in 88.5% of cases. The lattice hypothesis is discarded. The prediction of absolute values remains conditioned on two inputs that the local model already delimits: the stabilized values of the moduli of the active locus—the Eguchi–Hanson resolution parameter and the periods of the T^3 —, which depend on the same potential whose coefficients are uncomputed, and the winding integers that assign each SM state to a 3-cycle of the E_8 unfolding.

RR charges: frequency normalization and invariance of the Dirac quantum

The comparison of the RR component of (3) with the exchange of a $(p+1)$ -form A_{p+1} , with action $S = \frac{\alpha_p}{2} \int F_{p+2}^* F_{p+2} + i\mu_p \int_{\text{branes}} A_{p+1}$, fixes Polchinski’s normalization $\mu_p^2/\alpha_p = 2\pi(4\pi^2\alpha')^{3-p}$. Substituting Lemma 1.2:

$$\frac{\mu_p^2}{\alpha_p} = 2\pi (2\pi\ell_g^2)^{3-p} = (2\pi)^{4-p} \left(\frac{c}{f_g}\right)^{2(3-p)} : \quad (11)$$

the RR charge quantum of each Dp -brane is fixed by the critical graviton frequency. For $p = 3$ (the self-dual D3-brane of IIB) the charge is a pure number, $\mu_3^2/\alpha_3 = 2\pi$, independent of f_g : the electric/magnetic self-dual point of the RR sector, the perturbative image of the balance point $e/g_1 = 2/3$ of the Englert flux (34).

Proposition 1.9 (Frequency invariance of the Dirac quantum). *For $p + p' = 6$ (Hodge-dual strengths, $F_{p+2} = *F_{8-p}$), the Dirac quantization condition $\mu_p\mu_{6-p}/\alpha_p = 2\pi n$, $n \in \mathbb{Z}$, is satisfied with $n = 1$ for any value of f_g :*

$$\left(\frac{\mu_p \mu_{6-p}}{\alpha_p}\right)^2 = \frac{\mu_p^2}{\alpha_p} \cdot \frac{\mu_{6-p}^2}{\alpha_{6-p}} = 2\pi(4\pi^2\alpha')^{3-p} \cdot 2\pi(4\pi^2\alpha')^{p-3} = (2\pi)^2. \quad (12)$$

Proof. Immediate from (11) with $\alpha_p = \alpha_{6-p}$: the factors $(4\pi^2\alpha')^{\pm(3-p)}$ cancel identically. The quantization is topological and survives the frequency parametrization intact.

Remark 1.10. The invariance (12) is consistent with the flux-quantization structure of QGT (§2.6): on the smooth 4-cycles of *bulk* the period is fractional ($N = 0.0138$, equation (35), dependent only on pure numbers), whereas the integer charge resides in the twisted sectors of the twelve loci of the orbifold, where Witten’s quantization [27] is realized with $n \in \mathbb{Z}$ via the orbifold cohomology (36) [28, 29]. Polchinski’s Dirac condition and the QGT twisted quantization express the same principle: *physical charge is integer where matter resides*.

Graviton factorization and the triple constraint on f_g

The massless NS–NS pole of (3) is the exchange of the graviton (and dilaton) between the branes: the long-range Newtonian interaction, whose strength defines $\kappa^2 = 8\pi G_N$ in the effective theory.

Proposition 1.11 (Frequency Newton constant and triple constraint). *QGT parametrizes the residue of the graviton pole via*

$$G_N = \frac{\hbar V_g}{3 m_g^2} = \frac{2c^5}{3\hbar f_g^2} = 6.6744 \times 10^{-11} \text{ m}^3/(\text{kg s}^2), \quad (13)$$

$$\text{equivalently } f_g = c^2 \sqrt{\frac{V_g}{3\hbar G_N}},$$

which reproduces the CODATA value 6.67430×10^{-11} with deviation $< 0.01\%$ in the direct route, and to $\leq 0.08\%$ through the three independent routes of the model (this frequency route; the dimensional reduction $\kappa_4^2 = \kappa_{11}^2/\mathcal{V}_7$ of §2.7; and the cosmological route of Section 3). Internal consistency requires that the same f_g that fixes α' in (4) and the RR charges in (11) also fix G_N in (13): QGT satisfies this triple constraint by construction, deriving all three quantities from the single parameter $f_g = 6.0419 \times 10^{42} \text{ Hz}$.

The IIA 9-form and the cosmological constant

The third result of [20] is the existence of a 9-form potential in the IIA string, previously unnoticed: its field strength F_{10} satisfies $d*F_{10} = 0$, which for a 10-form implies $*F_{10} = \text{const}$. There are no solutions at nonzero momentum, but the constant solution acts as a background electric field that contributes to the cosmological constant a contribution proportional to the square of the field: a cosmological constant “of undetermined magnitude”.

QGT Identification 1.12 (The undetermined magnitude, parametrized). QGT proposes to fix precisely that magnitude via the cosmological frequency f_Λ :

$$\Lambda = \frac{f_\Lambda^2}{c^2} = 1.1056 \times 10^{-52} / \text{m}^2, \quad \rho_\Lambda = \frac{3\hbar f_g^2 f_\Lambda^2}{V_g^3} = 5.32 \times 10^{-10} \text{ J/m}^3, \quad (14)$$

with the structural correspondence

$$*F_{10} \longleftrightarrow \sqrt{2\rho_\Lambda} \propto f_g f_\Lambda, \quad (15)$$

and the hierarchy relation

$$f_\Lambda^2 f_g^3 = f_p^5 \times 10^{-123}, \quad (16)$$

which parametrizes (without dynamically resolving) the hierarchy $\rho_{\text{QFT}}/\rho_\Lambda \sim 10^{122}$. Polchinski’s speculation about the quantization of F_{10} in string units —nucleation of 9-branes that shifts $*F_{10}$ in discrete units— points to the same type of discrete mechanism that QGT localizes in its twisted sectors (§2.6).

Remark 1.13 (Mandatory delimitation). The correspondence (14)–(15) is an effective parametrization: the reduction of QGT produces an AdS_4 vacuum of Englert type ($\Lambda_4 < 0$) and the *uplift* to de Sitter with the observed value remains an open problem, shared with the generality of M-theory compactifications [30–32]. The full cosmological development is presented in Section 3, whose root equation (44) reduces to (14) using $\gamma = f_g^2/f_p^2$ and $V_g = 2c$.

1.3 Hypotheses

Within the framework of QGT, where the energy and vibration of the strings/particles depend exclusively on the frequency f , the Kalb–Ramond (KR) torsion field is identified with the ER = EPR duality and is interpreted as a hypertoric wormhole [4, 5] (Section 5): an Einstein–Podolsky–Rosen entangled pair [33] with a counter-rotational matter/antimatter

structure (M_g) circulating around the z -axis at luminal speeds and opposite angular velocities ω (Figure 4). The dilatonic radius of the graviton $a = R_g = c/(2\pi f)$ defines the hypersurface $A_0 = c^2/(4\pi f^2) = \pi R_g^2$, where the vacuum information resides, and the circulation or magnetic momentum $\Gamma_0 = \oint_C \mathbf{V} \cdot d\mathbf{A} = qA_0 = 2\omega A_0 = c^2/f$ fixes, by Stokes' theorem, the relative velocity of the KR field $V_g = qR_g = 2c$ and quantizes the torsion as an antisymmetric magnetic monopole $B_{\mu\nu}$ defined in the extra dimension w , whose transitions depend on f . The full development of this reading —Rankine profile, Stokes, invariant $\Gamma_0 f = c^2$ and identity $\Phi_B = h/2e$ — is collected in [34]. In QGT, as in M-theory, M-brane solutions generate spin-2 gravitons, where the KR field alters the brane vibrations [5, 14, 15] (Figures 3–11).

According to the central postulate of QGT, electricity, gravity, the G-force, magnetic fields, and matter are not fundamental entities, but emergent states of the vacuum that manifest as the frequency of light progressively decreases, splitting into positive and negative components. This chain of frequency transmutation is synthesized in the following sequence:

$$\Phi(f_\Omega) \xrightarrow{\Delta f \downarrow} \Phi(f_Q) \xrightarrow{\Delta f \downarrow} \Phi(f_\gamma) \xrightarrow{\Delta f \downarrow} \Phi(f_E) \xrightarrow{\Delta f \downarrow} \Phi(f_G) \xrightarrow{\Delta f \downarrow} \Phi(f_{F_g}) \xrightarrow{\Delta f \downarrow} \Phi(f_B) \xrightarrow{\Delta f \downarrow} \Phi(f_M),$$

where each arrow indicates a decrease in frequency ($\Delta f \downarrow$) that gives way to a new physical structure, culminating in matter. The reverse process ($\Delta f \uparrow$) corresponds to the ascent in the seven-frequency cone, recomposing light from matter or returning matter to the primordial vacuum (Section 7) [25]. This sequence of frequency, energy and vibration reproduces the Standard Model masses shown in Table 3 through Eq. (20). The key parameters ($f_g, f_\Lambda, V_g = 2c, \ell_g, F_g$) arose initially by heuristic inference from that cone of 7 frequency levels, and find their precise mathematical realization in the compactification on G_2 holonomy. In the framework of 11D supergravity with torsion $H_3 = h\varphi$ (class $\mathcal{W}_1 \oplus \mathcal{W}_4$), the critical graviton frequency f_g simultaneously fixes the characteristic torsion $\tau_0 = \sqrt{8\pi/7} f/c$, the torsional velocity $V_g = 2c$, the mass relation $m_i = m_g f_i/f_g$ and the horizon constant $\mathcal{K}_\beta = 16\pi/3$. Thus, the decrease of frequency is the geometric mechanism by which torsion and the Englert flux generate the polarity that manifests as electromagnetism and gravity. The inverse process (increase of frequency) produces fusion, matter-radiation annihilation and coherent rotation, closing the light-matter-light transmutation cycle —the variation of frequency that the ancient wisdom calls *the principles of light* (Section 7). This duality represents, in the sense of Thomas Kuhn [35], a **paradigm shift**: from a fragmented physics to a geometric-frequency unification where cosmological origin and microscopic structure are two faces of the same torsional duality. Ancient wisdom captured the intuition; QGT elevates it to a formalism derivable from first principles.

Epistemic delimitation. QGT does not depend on philosophical readings for its internal consistency. These are cited as motivational context whose only admissible test is the physics derived from first principles.

On the physical plane, the light-matter transmutation via photon-photon collisions corresponds to the Breit–Wheeler process [24, 36], with partial experimental support in “slow light” studies and Bose-Fermi condensates [37–42]. A duality is established: **Inverse photoelectric effect**: Photons in low-frequency atmospheres (e.g. metals) reduce the threshold f , splitting into electron-positron pairs that generate electric current. **Annihilation**: Increasing f converts matter into light [4, 5]. In quantum mechanics (QM), motion in an extra dimension w requires a threshold energy inversely proportional to the graviton radius R_g . Collisions that reach the threshold f allow opposite rotations in w .

The particle/antiparticle pairs $M_{(+)}/M_{(-)} = M_g$ materialize the identity $KR=ER=EPR$ [4, 5, 33, 43], conserving energy and momentum during transmutation. From the simple-pendulum equation and GR we have that gravity (G) emerges as a *counter-rotating EM field*, representing the acceleration of the Kalb-Ramond (KR) field where the change of quantum state depends on f [4, 5]:

$$G = \pi V_g f = 2\pi c f. \quad (17)$$

From the dynamics of the KR field in Figure 3 one can reproduce QM constants such as Planck's h :

$$h = 2\omega A_0 M_g = \omega A_0 M_{(+)} + \omega A_0 M_{(-)} \quad (18)$$

In upcoming sections, we will review some derivations that include: relative KR torsional velocity $V_g = \tau_g/F_g = 2c$, with centrifugal force or G-force $F_g = M_g G$ ($G \neq G_N$), torsional power $\tau_g = qE_g$, gravitational potential energy $E_g = \hbar G/c = F_g R_g$, reduced $\hbar = P R_g$, and $M_g = h/\Gamma_0$ in positive/negative fusion. Results: torsional hypersurface $S_g = V_g^2/(12\pi f^2) = \gamma V_g^2/(4f^2)$ with $\gamma = f_g^2/f_p^2 = 1/(3\pi)$. A “Gedankenexperiment” thought experiment [4] describes an entangled singularity forming a KR toroid, inducing a critical graviton frequency f_g proper to a *quantum jump*:

$$f_g = c^2 \sqrt{\frac{V_g}{3\hbar G_N}} = 6.0419 \times 10^{42} \text{ Hz}. \quad (19)$$

It alternates with γ or $\alpha' = V_g^2/(8\pi f_g^2)$. The graviton mass $m_g = h/\Gamma_g = 4.45 \times 10^{-8}$ kg is dual to the quantum-vacuum inertia hypothesis [44]. Discrete vibrational modes on M2-branes correlate with f_g , influenced by M5-branes and RR charges, modifying the space-time topology and aligning masses [5, 15]. The G-force F_g is dual to the *strong nuclear force and EM force inextricably bound together*. The potential energy E_g is dual to the *nuclear binding energy* [4, 5]. In M-theory, M-brane solutions generate spin-2 gravitons; the KR field alters brane vibrations [5, 14, 15] (figures 1— 4).

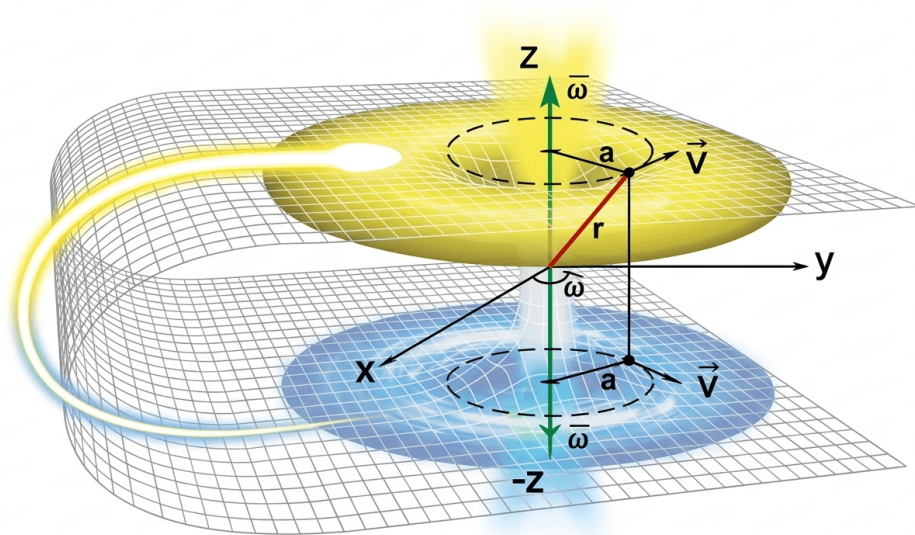


Figure 4: $KR=ER=EPR$ Wormhole [5].

1.4 Reproduction of Universal and SM Constants

In QGT, the critical graviton frequency f_g , its boundary mass or kinetic energy m_g , the dilaton radius R_g , the graviton magnetic momentum Γ_g and the KR velocity V_g (see Table 1) allow one to reproduce with precision numerous fundamental constants of the universe (see Table 2) and the rest masses of the SM particles (Table 3). Each fundamental constant is reproduced in a unified way with the SM, showing key simplifications. Furthermore, the SM rest masses are related as:

$$m_i = m_g \frac{f_i}{f_g} \quad (20)$$

For each particle i , for example the Higgs boson $m_H = m_g \frac{f_H}{f_g}$, this implies a transformative paradigm in QGT, where the rest masses m_i emerge from a frequency resonance unified with the graviton (f_g , m_g), suggesting that the SM particles are not fixed entities, but dynamical states in a continuous frequency spectrum. The relation $m_i = m_g \frac{f_i}{f_g}$ indicates that mass is proportional to the specific frequency f_i , with f_g as the gravitational cutoff scale, analogous to the Planck frequency f_p in the proportion:

$$\frac{m_i}{m_p} = 2\pi \frac{f_i}{f_p} \quad (21)$$

Table 1: QGT parameters derived from f_g (graviton frequency), f_p (Planck frequency), f_e (electron/Compton frequency), and known constants [4, 5].

Name	Symbol	Equation in QGT
KR relative velocity	V_g	$= 2c$
Graviton mass	m_g	$= \frac{hf_g}{c^2}$
Planck magnetic momentum	Γ_p	$= \frac{c^2}{f_p}$
Electron magnetic momentum	Γ_e	$= \frac{c^2}{f_e}$
Graviton dilaton radius	R_g	$= \frac{c}{2\pi f_g}$
Graviton magnetic momentum	Γ_g	$= \frac{c^2}{f_g}$
Electron dilaton radius	R_{ge}	$= \frac{c}{2\pi f_e}$

Table 2: QGT equations of universal constants, derived and reproduced in terms of f_g , m_g , V_g , Γ_g , Γ_p , Γ_e , R_g , R_{ge} and known parameters [4, 5]. The numerical values obtained via QGT equations are consistent with accepted observations [10].

Name	Symbol	Equation in QGT
Rydberg	R_∞	$= \frac{ce^4}{18\epsilon_0^2 G_N^2 m_g^2 \Gamma_e} = \frac{\alpha^2 f_e}{V_g}$
Newton gravitation	G_N	$= \frac{hV_g}{3m_g^2}$
Planck mass	m_P	$= \frac{\hbar}{\Gamma_p}$
Planck time	t_p	$= \frac{1}{f_g \sqrt{3\pi}}$
Planck temperature	T_p	$= \frac{\hbar f_g \sqrt{3\pi}}{k_B}$
Boltzmann	k_B	$= \frac{\hbar f_g \sqrt{3\pi}}{T_p}$
Sommerfeld hyperfine	α	$= \frac{e^2}{3\epsilon_0 G_N m_g^2} = \frac{e^2}{\epsilon_0 h V_g} = \frac{R_{ge}}{a_0}$
Avogadro	N_A	$= \frac{M_u A_{re} f_g}{m_g f_e}$
Faraday	F	$= \frac{e M_u A_{re} f_g}{m_g f_e}$
Ideal gas	R	$= \frac{N_A c^3 \Gamma_p}{T_p G_N}$
Bohr radius	a_0	$= \frac{\epsilon_0 h R_{ge} V_g}{e^2}$
Bohr magneton	μ_B	$= \frac{e \hbar f_g}{2 m_g f_e}$
Regge	α'	$= \frac{V_g^2}{8\pi f_g^2}$

Table 3: Rest masses of SM particles derived in QGT, in terms of f_g and the graviton m_g , f_i (specific frequency of particle i) [4, 5]. The numerical values obtained via QGT equations are consistent with accepted observations [11].

Name	Symbol	Equation in QGT
Proton	m_p	$= m_g \frac{f_p}{f_g}$
Neutron	m_n	$= m_g \frac{f_n}{f_g}$
Pion	m_{π^+}	$= m_g \frac{f_{\pi^+}}{f_g}$
D Meson	m_{D^+}	$= m_g \frac{f_{D^+}}{f_g}$
Electron	m_e	$= m_g \frac{f_e}{f_g}$
Muon	m_μ	$= m_g \frac{f_\mu}{f_g}$
Tau	m_τ	$= m_g \frac{f_\tau}{f_g}$
Electron neutrino	m_{ν_e}	$= m_g \frac{f_{\nu_e}}{f_g}$
Up quark	m_u	$= m_g \frac{f_u}{f_g}$
Down quark	m_d	$= m_g \frac{f_d}{f_g}$
Charm quark	m_c	$= m_g \frac{f_c}{f_g}$
Strange quark	m_s	$= m_g \frac{f_s}{f_g}$
Higgs boson	m_H	$= m_g \frac{f_H}{f_g}$
W boson	m_W	$= m_g \frac{f_W}{f_g}$
Z boson	m_Z	$= m_g \frac{f_Z}{f_g}$

1.5 Structural dualities and bridge with the G_2 compactification

The parametrized M/IIa dictionary

The lift of the IIa string to M-theory [14, 16] relates the radius of the eleventh dimension and the 11D Planck length with the string scale via $R_{11} = g_s \ell_s$ and $\ell_{11} = g_s^{1/3} \ell_s$. In QGT, the string coupling is fixed by the structural coincidence $\mathcal{K}_\beta = K|_{\min} = 16\pi/3$ (Section 4 and §2.3) through $g_s = \mathcal{K}_\beta/4\pi = 4/3$, and the string scale by Lemma 1.2, $\ell_s = \ell_g$. The parametrized dictionary is then

$$g_s = \frac{\mathcal{K}_\beta}{4\pi} = \frac{4}{3} > 1, \quad R_{11} = g_s \ell_g = \frac{4}{3} \ell_g, \quad \ell_{11} = g_s^{1/3} \ell_g \approx 1.10 \ell_g, \quad (22)$$

consistent to order $\mathcal{O}(1)$ with the QGT identification $R_{11} = \ell_g$: the M-theory circle is of the size of the graviton wavelength, and the regime is genuinely non-perturbative ($g_s > 1$), in agreement with the order-one torsion $\tau_0 \ell_g = \sqrt{8\pi/7} \approx 1.895$ of (32). The tension of the D-branes is then fixed by f_g : $T_p \propto (g_s \ell_g^{p+1})^{-1} = \frac{3}{4} f_g^{p+1}/c^{p+1}$.

Lemma 1.14 (The string coupling as torsional velocity). *With the rescalings of Section 4 ($r_g = c/(4\pi f_g)$, $M_g = m_g = \hbar f_g/c^2$) and the general form of the Newton constant of Table 2, $G_N = \hbar V_g/(3m_g^2)$, the quantized-horizon constant is a function exclusively of the torsional velocity, with f_g canceling identically:*

$$\mathcal{K}_\beta = \frac{2 G_N M_g}{c^2 r_g} = \frac{8\pi V_g}{3c}, \quad \implies \quad g_s = \frac{\mathcal{K}_\beta}{4\pi} = \frac{2 V_g}{3c}. \quad (23)$$

Proof. $\frac{2 G_N M_g}{c^2 r_g} = \frac{2 \hbar V_g}{3 m_g^2} \cdot m_g \cdot \frac{4\pi f_g}{c^3} = \frac{8\pi V_g}{3} \cdot \frac{\hbar f_g}{m_g c^3} = \frac{8\pi V_g}{3} \cdot \frac{c^2}{c^3} = \frac{8\pi V_g}{3c}$, using $m_g c^2 = \hbar f_g$.

The string coupling is, literally, the torsional velocity measured in units of $\frac{3}{2}c$.

Proposition 1.15 (Resolution of the observation $8/3 = 2g_s$). *With the Eguchi–Hanson factor in its exact form $\text{EH} = \hbar f_g^2 \Lambda/(c\rho_\Lambda) = V_g^3/(3c^3)$ (108) of the Supplementary Material and Lemma 1.14, the following hold:*

$$(i) \text{ EH} = \frac{9}{8} g_s^3 \quad (\forall V_g); \quad (ii) \text{ EH} = 2g_s \left(\frac{V_g}{2c} \right)^2; \quad (iii) \mathcal{K}_\beta = 2\pi \text{EH} \left(\frac{2c}{V_g} \right)^2. \quad (24)$$

Consequently, $\text{EH} = 2g_s$ if and only if $V_g = 2c$; with $V_g = 2c$ (Proposition 1.5), $g_s = 4/3$, $\text{EH} = 8/3$ and $\mathcal{K}_\beta = 2\pi \text{EH} = 16\pi/3$ are exact. The relation $8/3 = 2g_s$ ceases to be conjectural: it is an internal theorem of the parametrization, logically equivalent to $V_g = 2c$.

Proof. (i) $\frac{9}{8} g_s^3 = \frac{9}{8} \cdot \frac{8V_g^3}{27c^3} = \frac{V_g^3}{3c^3} = \text{EH}$. (ii) $2g_s(V_g/2c)^2 = \frac{4V_g}{3c} \cdot \frac{V_g^2}{4c^2} = \frac{V_g^3}{3c^3}$. (iii) $2\pi \text{EH}(2c/V_g)^2 = \frac{2\pi V_g^3}{3c^3} \cdot \frac{4c^2}{V_g^2} = \frac{8\pi V_g}{3c} = \mathcal{K}_\beta$. From (ii), $\text{EH} = 2g_s \Leftrightarrow (V_g/2c)^2 = 1 \Leftrightarrow V_g = 2c$ (positive root); equivalently, from (i), $\frac{9}{8} g_s^3 = 2g_s$ has the unique positive solution $g_s = 4/3$. At $V_g = 2c$, (iii) gives $\mathcal{K}_\beta = 2\pi \text{EH}$.

Remark 1.16 (Delimitation of the theorem). What is proven is that EH , g_s and $\mathcal{K}_\beta$ derive from the *single* parameter V_g/c and are simultaneously fixed by the channel duality ($V_g = 2c$): the equality $8/3 = 2g_s$ is internal to the parametrization, not a numerical coincidence. The *geometric* half remains open: to reconstruct the value $8/3$ of the volume of the Eguchi–Hanson *blow-ups* [45, 46] from the string dynamics and to prove that it coincides with the kinematic route $V_g^3/3c^3$. The complete chain, with its two corollaries ($\gamma = 1/(3\pi)$ exact; irreducible separation of $K|_{\min}$), is developed in the Appendix, §N.3 of the Supplementary Material.

QGT postulates and literature: comparative table

Table 4 consolidates the linkage of each postulate of the model with the literature, the corresponding parametric adaptation and its epistemic status. The logical chain is the following: the internal geometry (rows 1–3) is fixed by theorems of the literature once the orbifold and the torsion class are chosen; the string sector (rows 4–7) is anchored to Polchinski’s computation via Lemma 1.2 and the Propositions 1.3–1.9; and the effective 4D sector (rows 8–11) inherits from Section 2 the formalism of Beasley–Witten and Lukas–Morris with the frequency parameters (f_g, f_p, f_Λ) .

Table 4: QGT postulates, the literature result to which they are linked, parametric adaptation and epistemic status. “Established” = physics/mathematics independently verified; “Derived” = consequence of a theorem once the QGT ansatz is adopted; “Parametrization” = consistent effective identification of the QGT framework; “Conjecture” = open structural hypothesis.

QGT postulate	Literature	Parametric adaptation	Status
$\mathcal{N} = 1$ vacuum on $X = T^7/(\mathbb{Z}_2)^3$ with E_8 unfolding	Joyce [47, 48]; Acharya–Witten [19]; Katz–Vafa–Bourjaily [49, 50]	$b_2 = 19, b_3 = 99$ (30); 3 families from $E_6 \times SU(3) \subset E_8$	Established (geom.); QGT identification of the locus
Torsion $H_3 = h\varphi$, class $\mathcal{W}_1 \oplus \mathcal{W}_4$	Fernández–Gray [51]; Friedrich–Ivanov [52]	$\tau_0 = \sqrt{8\pi/7} f/c; \tau_1 = d \ln h, h \propto f$ (32)	Derived + parametrization
Balanced Englert flux $e/g_1 = 2/3$	Englert [53]; Duff–Nilsson–Pope [54]	$e = \tau_0 = \frac{2}{3}g_1, g_1 = \sqrt{18\pi/7} f/c; R = G_4 ^2/6$ (34), (33)	Derived + parametrization
String / Regge scale	Polchinski [20]	$\alpha' = \ell_g^2/2\pi, \ell_s = \ell_g$ (4)	Parametrization
Channel duality as resonance at f_g	Polchinski [20]	$f_{\text{can}} \tilde{f}_{\text{can}} = f_g^2$; self-dual at f_g (6)	Parametrization
Torsional velocity $V_g = 2c$	channel duality [20]	relative channel velocity (7); balance (8)	Parametrization
RR Dirac quantum $n = 1$	Polchinski [20]; Witten [27]	invariant under f_g (12); twisted sectors (35)–(36) [28, 29]	Established (topological)
Mass pattern $m_i = m_g f_i/f_g$	stretched string [20]; M2 instantons [8, 26]	$m_Y = m_g Y/\ell_g$ (9); $\text{Vol}(\Sigma_i)/\ell_{11}^3 = \ln(f_g/f_i)$ (10)	Parametrization
Superpotential and Kähler potential	Gukov [55]; Beasley–Witten [9]; Lukas–Morris [46]	$W_{\text{QGT}} = \kappa_{11}^{-2} \int_X G_4 \wedge \varphi$ (H) of the Supplementary Material in f variables; $K _{\min} = 16.69$ (29)	Parametric adaptation (Section 2)
G_N by three routes	graviton pole [20]; KK reduction [9]	$G_N = 2c^5/(3hf_g^2)$ (13); $\kappa_4^2 = \kappa_{11}^2/\mathcal{V}_7$	Verified parametrization ($\leq 0.08\%$)
Λ, ρ_Λ and hierarchy	IIa 9-form [20]; CC problem [32, 56]	$\Lambda = f_\Lambda^2/c^2$ (14); $f_\Lambda^2 f_g^3 = f_p^5 \times 10^{-123}$ (16)	Parametrization; dS <i>uplift</i> open
Geometric torsion vs. flux	Dall’Agata–Prezas [57]	<i>twisted tori</i> versus Englert flux (Appendix, §I)	Structural contrast
KR = ER = EPR	Maldacena–Susskind [6, 7]	two-sheeted torsion $T^7 \rightarrow X$ (Sections 4–5)	Conjecture

Consolidated numerical and dimensional verification

Table 5 collects the numerical verification of the identifications of this section, recomputed with $c = 2.99792458 \times 10^8$ m/s, $h = 6.62607015 \times 10^{-34}$ J s and $G_N^{\text{CODATA}} = 6.67430 \times 10^{-11}$ m³/(kg s²) [10]. All expressions are dimensionally homogeneous in SI; in particular, $[\alpha'] = \text{m}^2$, $[\Lambda] = 1/\text{m}^2$ and $[\rho_\Lambda] = \text{J}/\text{m}^3$.

It is worth emphasizing the nature of the relation $K|_{\min} \approx \mathcal{K}_\beta$: numerically, 16.689 versus $16\pi/3 = 16.755$ (0.39%). Its status is resolved in two halves by Proposition 1.15 and the Appendix (§N.3 of the Supplementary Material). On the one hand, $\mathcal{K}_\beta = 2\pi \text{EH} = 16\pi/3$ and $\text{EH} = 2g_s$ are internal *theorems* of the parametrization, logically equivalent to

Table 5: Numerical verification of the parametric identifications of Section 1, with $f_g = 6.0419 \times 10^{42}$ Hz, $f_p = 1.855 \times 10^{43}$ Hz, $f_\Lambda = 3.1523 \times 10^{-18}$ Hz, $V_g = 2c$.

Quantity	QGT expression	Computed value	Contrast
f_g	$c^2 \sqrt{V_g/(3hG_N)}$	6.0419×10^{42} Hz	definition (13)
$\ell_g = \ell_s$	c/f_g	4.9619×10^{-35} m	$= R_{11}$ (§2.3)
α'	$\ell_g^2/2\pi$	3.918×10^{-70} m ²	Lemma 1.2
m_g	hf_g/c^2	4.454×10^{-8} kg	$= 2\sqrt{\pi/3} m_P = 2.047 m_P$
G_N	$2c^5/(3hf_g^2)$	6.6744×10^{-11}	CODATA: dev. < 0.01%
γ	f_g^2/f_p^2	0.10609	$1/3\pi = 0.10610$: 0.02%
$\tau_0 \ell_g$	$\sqrt{8\pi/7}$	1.895	$\mathcal{O}(1)$, non-pert. regime
g_s	$\mathcal{K}_\beta/4\pi$	4/3	$R_{11} = g_s \ell_g$ (22)
$K _{\min}$	$-3 \ln[(8/3)^{7/3} \gamma^{7/2}]$	16.689	$16\pi/3 = 16.755$: 0.39%
Λ	f_Λ^2/c^2	1.1056×10^{-52} /m ²	Planck 2018 [12]
ρ_Λ	$3hf_g^2 f_\Lambda^2/V_g^3$	5.32×10^{-10} J/m ³	Planck 2018 [12]
Hierarchy	$f_\Lambda^2 f_g^3/f_p^5$	1.0×10^{-123}	$\rho_{\text{QFT}}/\rho_\Lambda$ (16)

$V_g = 2c$. On the other, $\gamma = 1/(3\pi)$ is exact —the Newton constant cancels in f_g^2/f_p^2 —, so that $K|_{\min} = 16.689$ is fixed without free parameters and its separation of 0.39% with respect to $\mathcal{K}_\beta$ is *irreducible* within the axioms: forcing exact equality would require $\gamma = 0.10544$, which would shift G_N by +0.63%, four orders of magnitude above the CODATA uncertainty (2.2×10^{-5}). The old “structural coincidence” thus ceases to be a pending demonstration problem and becomes a quantified structural approximation; the only remaining open question is geometric (Remark 1.16).

What each section inherits

The Propositions of §1.2 constitute the input data of the rest of the work. Section 2 inherits the anchoring $\ell_s = \ell_g = R_{11}$ of Lemma 1.2 and the triple constraint of Proposition 1.11, which its Kaluza–Klein reduction verifies independently ($\kappa_4^2 = \kappa_{11}^2/\mathcal{V}_7$); its flux quantization in twisted sectors realizes geometrically the invariance of the Dirac quantum (Proposition 1.9). Section 3 inherits the cosmological parametrization of the Identification 1.12, whose root equation (44) reduces to $\Lambda = f_\Lambda^2/c^2$. Sections 4 and 5 develop the conjecture $\text{KR} = \text{ER} = \text{EPR}$, for which Polchinski’s cylinder provides the diagrammatic skeleton: the exchange of the closed string is the geometric “bridge” and the counter-rotating open pair the entangled pair. Section 6 derives kinematically $V_g = 2c$, in agreement with Proposition 1.5, and anchors the matter/antimatter symmetry in the involution $\mathbb{Z}_2$ of the orbifold (Identification 1.1).

1.6 Discussion

Propositions 1.3–1.11 and Lemma 1.2 raise the interaction system of this section from heuristic analogy to exact parametric adaptation of Polchinski’s computation, with the triple constraint on f_g and the comparative table of Table 4 as synthesis.

The energy-conservation principle is reinterpreted as resonant transmutation: where one and the same particle (or string) can evolve through frequency levels, from high ($f \rightarrow f_g$, strings/bosons) to low ($f \ll f_g$, hadrons/solid atoms), and vice versa, without

violating total conservation. This evokes fusion/fission via the KR vortex, where harmonic resonance (f_i/f_{ii}) modulates states without destructive collisions, reducing free parameters of the SM (e.g., Yukawa) to geometric frequencies in dimensions w compactified on G_2 [4, 5].

The pertinent contribution is the promotion of frequency to the rank of a fundamental dynamical variable — an active field $f_{(X)}$ from which the metric, electromagnetism (EM) and quantum mechanics (QM) derive — with an explicit 11D action. Phenomenologically, it suggests experiments of torsion-field-induced transmutation in colliders (LHC) or high-frequency lasers, probing the continuous spectrum. Theoretically, it aligns with AdS/CFT [1], where dual frequencies encode holography, with potential to resolve hierarchies and the naturalness of the Higgs vacuum via f_g as a universal regulator. Perhaps the G-force F_g is dual to the *strong nuclear force and EM force inextricably bound together*. The gravitational potential energy E_g is dual to the *nuclear binding energy* in the context of quantum chromodynamics (QCD) [4, 5].

The ability to reproduce with precision all these constants, unified across different physical domains, and the creation of new fundamental constants suggest that these constants emerge from an underlying quantum structure in the vacuum, transforming the understanding of natural laws. The conservation principle allows transmutation (fusion/fission) via resonance, reducing free parameters of the SM and addressing hierarchies, naturalness and Higgs-vacuum stability, contributing to interaction theories and experiments on universal structure.

It also offers key contributions to the study of quantum phase transitions, where systems change between distinct energy states —from superconducting condensates to extreme configurations such as black holes—, consistent with the phenomenological approach to order parameters and spontaneous symmetry breaking [58]. What requires further development is the explicit solution of the Dirac equation in the background with torsion ($H_3 \neq 0$) on the specific G_2 manifold, showing the step-by-step derivation of how each Kaluza-Klein mode acquires the mass $m_i = m_g \frac{f_i}{f_g}$ of Table 3. This mechanism is formalized in the geometric development of Section 2: the masses are generated by M2 membrane instantons wrapping associative 3-cycles Σ_i of the active locus of the G_2 manifold, with $m_i = m_g \exp(-\text{Vol}(\Sigma_i)/\ell_{11}^3)$, so that $\text{Vol}(\Sigma_i)/\ell_{11}^3 = \ln(f_g/f_i)$, in the twofold brane-to-brane/instantonic reading of equation (10). The volumes required for the Standard Model fermions fall in the range $39\text{--}52 \ell_{11}^3$, instanton-action values consistent with a compact G_2 manifold; the relation $m_i = m_g(f_i/f_g)$ thus acquires the interpretation of a spectrum of 3-cycle volumes. The local model reduces the problem from a full spectrum to four moduli and three winding integers per family; its first-principles derivation is conditioned on the stabilization of those moduli and on the correction of the Joyce metric relative to the local model, unknown in closed form.

2 Generalized Action and G_2 Holonomy

This section specifies in detail the compactification of eleven-dimensional supergravity underlying QGT, addressing the M-theory construction on manifolds of G_2 holonomy: *which* internal manifold, *which* torsion class, *which* type of flux, and the explicit form of the *four-dimensional effective action*. The development follows the standard treatment of flux superpotentials of Beasley–Witten[9, 55] and the moduli Kähler potential of Lukas–Morris [46], the torsion classification of Fernández–Gray [51, 59], and the unfolding mechanism of an E_8 singularity of Bourjaily [50]. Each result is accompanied by its numerical verification with the frequency parameters of Section 1. The input data of the construction are the three anchors demonstrated there: the string scale $\ell_s = \ell_g = R_{11}$ (Lemma 1.2), the triple constraint on f_g that simultaneously fixes α' , the RR charges and

G_N (Proposition 1.11), and the topological invariance of the Dirac quantum (Proposition 1.9), which the quantization in twisted sectors of §2.6 realizes geometrically.

2.1 Conventions and parameters

One distinguishes the wavelength $\ell = c/f$ from the reduced radius $R = c/(2\pi f) = \ell/2\pi$; the compactification radius of the eleventh dimension is the graviton wavelength, $R_{11} \equiv \ell_g = c/f_g$. The associative 3-form φ is taken dimensionless (radii normalized by ℓ_g); the flux G_4 has dimension L^{-1} , so that $|G_4|^2$ is homogeneous with the Ricci scalar in $R = |G_4|^2/6$. The fundamental parameters are $f_g = 6.0419 \times 10^{42}$ Hz, $f_p = 1.855 \times 10^{43}$ Hz, $f_\Lambda = 3.1523 \times 10^{-18}$ Hz and $V_g = 2c$, whence $\ell_g = 4.9619 \times 10^{-35}$ m, $\ell_p = c/f_p = 1.6161 \times 10^{-35}$ m and the geometric coupling parameter

$$\gamma = \frac{f_g^2}{f_p^2} = \frac{\ell_p^2}{\ell_g^2} = \frac{f_p^3}{f_g f_\Lambda^2} \times 10^{-123} = \frac{1}{3\pi} = 0.106103. \quad (25)$$

2.2 The generalized action

The starting bosonic action is that of 11D supergravity [3] enriched with the torsion and topological terms characteristic of QGT:

$$S = S_{\text{EH}} + S_{H_3} + S_{G_4} + S_{\text{top}}, \quad (26)$$

with the Einstein–Hilbert term $S_{\text{EH}} = \frac{1}{2\kappa_{11}^2} \int d^{11}x \sqrt{-G} R$, the Kalb–Ramond torsion term $S_{H_3} \propto \int H_3 \wedge \star H_3$ modulated by the geometric factor $(8/3)^{7/3}$, the kinetic term of the 4-form $S_{G_4} = -\frac{1}{2} \int G_4 \wedge \star G_4$, and the Chern–Simons topological term $S_{\text{top}} \propto \int C_3 \wedge dH_3 \wedge G_4$. The reduction of this action on the internal manifold, with its specific torsion and flux, produces the effective $\mathcal{N} = 1$ theory in 4D detailed in §2.7.

2.3 The G_2 manifold: Joyce’s orbifold

The internal manifold is the compact Joyce orbifold [47, 48]

$$X = T^7/\Gamma, \quad \Gamma = \mathbb{Z}_2 \times \mathbb{Z}_2 \times \mathbb{Z}_2, \quad (27)$$

with generators that each invert four coordinates (preserving the associative 3-form) and incorporate shifts of $\frac{1}{2}$ that make the products $\alpha\beta, \alpha\gamma, \beta\gamma, \alpha\beta\gamma$ act freely. Consequently only the three generators possess a fixed locus, generating twelve singular loci of codimension four, each with transverse singularity $\mathbb{C}^2/\mathbb{Z}_2$. The first Betti number vanishes ($b_1 = 0$), a necessary condition for G_2 holonomy. This class of Joyce $\mathbb{Z}_2$ orbifolds admits a dual realization as a type-IIA orientifold, established by Kachru and McGreevy and developed by Govindarajan and Majumder [60–62], in which the M-theory compactification on the G_2 manifold arises as the strong-coupling limit of the orientifold; the toroidal presentation employed here—with X written as $(T^6/(\mathbb{Z}_2)^2 \times S^1)/\mathbb{Z}_2$ and the remaining generator acting as an anti-holomorphic involution combined with the S^1 inversion—is the case treated in [63, 64].

The *resolution is asymmetric*: eleven loci receive the standard smooth blow-up (Eguchi–Hanson ALE space) and a single locus carries, in its normal direction, the complete unfolding of an E_8 singularity toward the Standard Model via the Katz–Vafa–Bourjaily mechanism [49, 50], adapted here from the original Calabi–Yau context to G_2 holonomy. The resolution of E_8 with four deformation parameters [65] (a, b, c, d) produces as generic fiber $SU(3) \times SU(2) \times U(1)^5$ and exactly 35 conical points that generate the chiral matter; that three families emerge is a consequence of group theory ($E_6 \times SU(3)$ is maximal in E_8), not a fitting. The eleven smooth loci contribute hidden $U(1)$ multiplets, candidates for the dark-matter sector.

In the isotropic vacuum, the seven radii take the common value

$$R_* = \left(\frac{8}{3}\right)^{1/3} \sqrt{\gamma} \ell_g = 1.387 \ell_p = 2.2413 \times 10^{-35} \text{ m}, \quad (28)$$

whence the internal volume and the stabilized Kähler potential:

$$\mathcal{V}_7 = \left(\frac{8}{3}\right)^{7/3} \ell_g^7 \gamma^{7/2} = 2.84 \times 10^{-243} \text{ m}^7, \quad K|_{\min} = -3 \ln \frac{\mathcal{V}_7}{\ell_g^7} = 16.69 \approx \frac{16\pi}{3}. \quad (29)$$

The Betti numbers of X , with the active locus carrying the eight divisors of the Cartan lattice of E_8 , are

$$b_2(X) = 11 + 8 = 19, \quad b_3(X) = 7 + 33 + 24 + 35 = 99, \quad (30)$$

corresponding to 19 vector multiplets and 99 chiral superfields.

Remark 2.1 (Constructive hypothesis of the asymmetric resolution). The mathematical existence of this asymmetric resolution —the active locus carrying the eight divisors of the Cartan lattice of E_8 and the 35 vanishing cycles counted as independent classes— is adopted as a constructive hypothesis of the model, with the same status as the conjectures declared in this work. The baseline demonstrated in the literature is $b_2 = 12$, $b_3 = 43$ [47, 48]; the proof of the asymmetric variant with these independent classes is an open problem. The twisted-connected-sum construction [66] shows that the landscape of compact G_2 manifolds is vast —and transitions between topologically distinct M-theory compactifications are an established phenomenon [67]—, which makes plausible the existence of such a resolution within it.

2.4 The torsion: Fernández–Gray class $\mathcal{W}_1 \oplus \mathcal{W}_4$

The Kalb–Ramond torsion $H_3 = dB$, a totally antisymmetric 3-form —identified with the torsion of the connection in supersymmetric compactifications since [68]—, determines the class of the G_2 -structure. By the Friedrich–Ivanov theorem [52], a totally antisymmetric torsion requires the vanishing of the adjoint component τ_2 (the **14** of $\mathfrak{g}_2$). The systematic framework relating classes of intrinsic torsion with fluxes and supersymmetry is developed in [69], and the reduction of M-theory on general G_2 structures with torsion and flux —the analysis closest to the situation of QGT— in [70]. This places QGT in the class

$$\tau_0 \neq 0, \quad \tau_1 = d \ln h, \quad \tau_2 = \tau_3 = 0 \iff X \in \mathcal{W}_1 \oplus \mathcal{W}_4, \quad (31)$$

reducing to the pure class $\mathcal{W}_1$ (*nearly parallel*: $d\varphi = \tau_0 \star \varphi$, $d \star \varphi = 0$) in the vacuum —a class characterized, equivalently, by the existence of a real Killing spinor, whose metric cone carries Spin(7) holonomy [71]. For this class, the characteristic torsion is proportional to the 3-form itself [52, 72], which *derives* the singlet ansatz:

$$H_3 = h \varphi, \quad h = \frac{\tau_0}{6}, \quad \tau_0 = \sqrt{\frac{8\pi}{7}} \frac{f}{c}, \quad \tau_0 \ell_g|_{f=f_g} \approx 1.895.^2 \quad (32)$$

The internal geometry is Einstein with positive curvature, $R_7 = \frac{21}{8} \tau_0^2 = 3\pi f^2/c^2$, verifiable with the sphere S^7 ($\tau_0 = 4 \Rightarrow \text{Scal} = 42$). Under a conformal change $\langle, \rangle^0 = e^{2\sigma} \langle, \rangle$, the 3-form generates the term $3 d\sigma \wedge \varphi$ with $\tau_1 = d\sigma$: the identification $\tau_1 = d \ln h$ with $h \propto f$ means that *the frequency field is the conformal factor of the G_2 -structure*, and the class $\mathcal{W}_1 \oplus \mathcal{W}_4$ is conformally invariant.

²The torsion is dimensional, $[\tau_0] = L^{-1}$; the pure number $\tau_0 \ell_g = \sqrt{8\pi/7} \approx 1.895$ measures it in units of the compactification scale $\ell_g = c/f_g$. The associated *nearly parallel* curvature radius, defined by $\text{Scal} = 42/R_{\text{curv}}^2 = \frac{21}{8} \tau_0^2$, is $R_{\text{curv}} = 4/\tau_0 \approx 2.11 \ell_g$; it is distinct from the isotropic volume radius $R_* = \mathcal{V}_7^{1/7} \approx 0.45 \ell_g$ and from $R_{11} = \ell_g$: curvature and volume define scales that only coincide on the round sphere. *Normalization convention*: one adopts $d\varphi = \tau_0 \star \varphi$ in the *nearly parallel* vacuum (Friedrich–Ivanov [52]), under which the round sphere S^7 has $\tau_0 = 4$ and $\text{Scal} = \frac{21}{8} \tau_0^2 = 42$; part of the literature employs $\lambda = \tau_0/4$ ($d\varphi = 4\lambda \star \varphi$), with $\lambda = 1$ for S^7 .

2.5 The 11D Einstein equation and the relation $R = |G_4|^2/6$

Since the Einstein–Hilbert term and the flux kinetic term share the prefactor $1/2\kappa_{11}^2$, upon varying the metric that constant cancels. Taking the trace of the field equation in $D = 11$:

$$-\frac{9}{2}R = -\frac{1}{32}G^2 \implies \boxed{R = \frac{|G_4|^2}{6}}, \quad |G_4|^2 = 18\pi \frac{f^2}{c^2}, \quad (33)$$

dimensionally consistent ($[|G_4|^2/6] = 1/\text{m}^2 = [R]$). If $G_4 = 0$, then $R = 0$ and one recovers the Ricci-flat manifold of exact G_2 holonomy (Bonan’s theorem [73]), one of the two exceptional entries of Berger’s holonomy classification [74]. This relation is one of the central identities of QGT: it ties the internal curvature directly to the flux norm, without free parameters.

2.6 The flux G_4 and its quantization

The flux is a two-component configuration of Englert type [53]:

$$G_4 = \underbrace{e \varepsilon_4}_{\text{Freund–Rubin}} + \underbrace{g_1 \star \varphi}_{\text{internal singlet}}, \quad e = \tau_0 = \sqrt{\frac{8\pi}{7}} \frac{f}{c}, \quad g_1 = \frac{3}{2}\tau_0 = \sqrt{\frac{18\pi}{7}} \frac{f}{c}, \quad (34)$$

where the Freund–Rubin component [75, 76] is required by the equation of motion of C_3 , which forces the Englert relation $\tau_0 = \pm 3m$ with $e = 3m$, whence $e = \tau_0$. The normalization of τ_0 —the Freund–Rubin amplitude, not Bryant’s W_1 class, with $\tau_0/\tau_B = 3/4$ —is declared in (Q.8) of the Supplementary Material. The relation $\tau_0 = \frac{2}{3}g_1$ is exact and independent of frequency.

The Dirac quantization on the coassociative 4-cycles of *bulk* produces, in the isotropic configuration, a pure number independent of f_g :

$$N = \frac{g_1 R_*^4}{(2\pi\ell_p)^3} = \sqrt{\frac{6}{7}} \frac{(8/3)^{4/3}}{8\pi^3} = 0.0138, \quad (35)$$

fractional. This value is *topologically admissible* in the framework of the Chen–Ruan orbifold cohomology [28]: only the three generators contribute twisted sectors (age = 1), so that

$$\dim H_{\text{orb}}^4(X) = b_4(X) + 12 \times 3 = 99 + 36 = 135, \quad (36)$$

and by the orbifold discrete-torsion mechanism [29], in consistency with Witten’s flux quantization [27], the twisted quanta are half-integers on the T^7 covering and integers on the quotient. The physical charge thus resides in the twisted sectors of the twelve loci, with the smooth bulk component carrying $N_{\text{bulk}} = 0$; the reproduction of the mean value $|G_4|^2$ fixes the transverse resolution scale of the blow-ups at $\ell_\perp \approx 10\ell_p$. Notably, the quantization pushes the flux charge to the same loci where matter resides, establishing the structural origin of the link between fluxes and masses.

2.7 The effective action in four dimensions

The reduction of 11D supergravity on X produces an $\mathcal{N} = 1$ supergravity in 4D whose bosonic action is

$$\begin{aligned} S_{4D} = \int d^4x \sqrt{-g_4} & \left[\frac{1}{2\kappa_4^2} R_4 - K_{IJ} \partial_\mu T^I \partial^\mu \bar{T}^J - \frac{63}{4\kappa_4^2} \frac{(\partial f)^2}{f^2} \right. \\ & - \frac{1}{4} \text{Re} f_{ab} F_{\mu\nu}^a F^{b\mu\nu} - e^K (K^{I\bar{J}} D_I W \overline{D_{\bar{J}} W} - 3|W|^2) \\ & \left. - \sum_{i=1}^{35} |D_\mu \Phi_i|^2 + \dots \right], \end{aligned} \quad (37)$$

with $b_3 = 99$ chiral superfields, $b_2 = 19$ vector multiplets and 35 matter multiplets (the three families). Each term has a verifiable physical content:

Gravitational sector. The reduction gives $\kappa_4^2 = \kappa_{11}^2/\mathcal{V}_7 = 6.434 \times 10^{-65} \text{ m}^2$. The comparison with the observed value reveals a single convention Jacobian between wavelengths and reduced radii:

$$\frac{\kappa_4^2}{8\pi\ell_p^2} = (2\pi)^5 (1.0008), \quad C_{2\pi} \equiv (2\pi)^5 = 9792.6, \quad (38)$$

so that with the effective volume $\mathcal{V}_7^{\text{eff}} = (2\pi)^5 \mathcal{V}_7$, the Newton constant is reproduced with a precision of 0.08%, consistent with the independent relation $G_g = (c^3/\hbar) V_g^2/(12\pi f_g^2) = G_N$ (0.07%). The same factor $C_{2\pi}$ normalizes the vacuum energy density $\rho_\Lambda = 3\hbar f_g^2 f_\Lambda^2/V_g^3$, closing simultaneously both normalizations with a single convention.

Frequency field. The identification of the radii as wavelengths, with the isotropic breathing mode $a \propto f^{-3}$, and the Kähler potential $K \supset -7 \ln(2a)$, produces the kinetic term of the frequency field with *derived* coefficient:

$$\mathcal{L}_{\text{kin}}(f) = -\frac{7}{4} \cdot 9 \frac{(\partial f)^2}{f^2} = -\frac{63}{4} \frac{(\partial f)^2}{f^2}. \quad (39)$$

The logarithmic term $(\partial f/f)^2$ is not a choice of the model but a consequence of $K = -3 \ln \mathcal{V}_7$.

Gauge sector and stabilization. The gauge-kinetic function gives $\alpha_a^{-1} \sim \text{Vol}(Q_a)/\ell_{11}^3$ [19, 77]; reproducing $\alpha_{\text{GUT}}^{-1} \approx 25$ requires $R_Q \approx 2.3 R_*$, a prediction of anisotropy of the active locus. With flux only the potential exhibits *runaway*; the stabilization requires M2-brane instantons (G_2 analogue of KKLT [30]), producing an AdS_4 minimum that coincides in sign with the Englert vacuum of (34) — an internal consistency by two independent routes. Three determinations of the scale of the active locus (flux $\ell_\perp \sim 10 \ell_p$, gauge $R_Q \sim 3.2 \ell_p$, stabilization $R_* \sim 1.4 \ell_p$) converge to the same supra-Planckian order.

Matter sector. The 35 conical points contribute the three families; their masses are generated by membrane instantons wrapping associative 3-cycles [26, 78]:

$$m_i = m_g \exp\left(-\frac{\text{Vol}(\Sigma_i)}{\ell_{11}^3}\right) \iff \frac{\text{Vol}(\Sigma_i)}{\ell_{11}^3} = \ln \frac{f_g}{f_i}. \quad (40)$$

The volumes required for the Standard Model fermions fall in the narrow range 39–52 ℓ_{11}^3 ; the relation $m_i = m_g(f_i/f_g)$ thus acquires the interpretation of a spectrum of 3-cycle volumes. This is the formalization of the mass mechanism anticipated in Section 1, whose conversion into a prediction of absolute values is conditioned on the computation of the explicit G_2 metric of the active locus.

2.8 Consolidated numerical verification

The results are collected in Table 6.

These same quantities — τ_0 , g_s and $|G_4|^2$ — run through the whole chain: the volume-modulus reduction derives g_s from the internal dimension alone (Section Q.3 of the Supplementary Material), and the very same parameters fix the dark-matter to dark-energy ratio $\Omega_{\text{dm}}/\Omega_\Lambda = 10\pi/81$ (Section Q.7 of the Supplementary Material), tying the Hubble tension of Section 3 to the internal geometry.

Quantity	Expression	Value
ℓ_g	c/f_g	$4.9619 \times 10^{-35} \text{ m}$
γ	f_g^2/f_p^2	$1/(3\pi) = 0.106103$
R_*	$(8/3)^{1/3} \sqrt{\gamma} \ell_g$	$2.2413 \times 10^{-35} \text{ m}$
$\mathcal{V}_7$	$(8/3)^{7/3} \gamma^{7/2} \ell_g^7$	$2.841 \times 10^{-243} \text{ m}^7$
$K _{\min}$	$-3 \ln(\mathcal{V}_7/\ell_g^7)$	$16.69 \approx 16\pi/3$
κ_4^2	$\kappa_{11}^2/\mathcal{V}_7$	$6.434 \times 10^{-65} \text{ m}^2 = (2\pi)^5 8\pi \ell_p^2$
τ_0	$\sqrt{8\pi/7} f_g/c$	$3.819 \times 10^{34} \text{ /m}; \tau_0 \ell_g = 1.895$
τ_0/g_1	exact	$2/3$
h	$\tau_0/6$	$6.365 \times 10^{33} \text{ /m}$
R_7	$\frac{21}{8} \tau_0^2 = 3\pi f_g^2/c^2$	$3.828 \times 10^{69} \text{ /m}^2 = f_p^2/c^2$
$ G_4 ^2$	$6R_7 = 18\pi f_g^2/c^2$	$2.297 \times 10^{70} \text{ /m}^2$
N	$\sqrt{6/7} (8/3)^{4/3} / (8\pi^3)$	0.0138
$\dim H_{\text{orb}}^4$	$99 + 36$	135
G_g	$(c^3/\hbar) V_g^2 / (12\pi f_g^2)$	$6.674 \times 10^{-11} = G_N$
b_2, b_3	Eq. (30)	$19, 99$

Table 6: Numerical verification of the geometric specification of Section 2.

2.9 Limitations and open problems

This reduction inherits the generic open problems of M-theory compactifications, enumerated and discussed in detail in Section R of the Supplementary Material. The most significant is the *uplift* $AdS_4 \rightarrow dS_4$: the smooth-flux branch produces an Englert vacuum with $\Lambda_4 \approx -1.94 \times 10^{69} \text{ /m}^2$, versus $\Lambda_{\text{obs}} \approx 1.11 \times 10^{-52} \text{ /m}^2$, requiring the cancellation of $\sim 10^{121}$ —a problem shared with the whole literature of the area—. The volume-modulus reduction, developed in Section Q of the Supplementary Material, fixes the exponents $(9, 15, 21)$ and with them the weight $g_s = 2(d-1)/(d+2)|_{d=7} = 4/3$ with which the Freund–Rubin energy enters $V_{\min}$, whence $m = \tau_0/3$ and $|\Lambda_4| = g_s \tau_0^2$ become theorems rather than identifications; the same formula proves $V_{\min} < 0$ at every critical point—a Maldacena–Nuñez-type no-go—so that this energy cannot be added again as an uplift. The open step is bounded to a finite computation: the one-loop vacuum energy on $T^7/(\mathbb{Z}_2)^3$ (channel $n = 18$) or the effective tension of the fixed T^3 loci (channel $n = 11$), whose natural scale M_{KK}^4 sits 244 orders away from Λ_{obs} —(249) of the Supplementary Material—, which is the quantitative statement of what remains to be established. Next come the stability of the Englert-type vacuum (whose Page–Pope tachyonic mode, in the **7** of G_2 , the orbifold projects out entirely, evading the instability of S^7), the global existence of the deformed *nearly parallel* metric, and the stabilization of the moduli of the active locus—the Eguchi–Hanson resolution parameter and the periods of the T^3 —together with the correction of the Joyce metric relative to the local model: the local model reduces the geometric mass framework to four moduli and three winding integers per family, and those are the inputs that would turn it into a quantitative prediction.

2.10 Discussion

This section has specified the G_2 compactification underlying QGT: the manifold $(X = T^7/(\mathbb{Z}_2)^3$ with E_8 unfolding on one locus), the torsion class $(\mathcal{W}_1 \oplus \mathcal{W}_4$, with $\tau_0 = \sqrt{8\pi/7} f/c$ and $\tau_0 = \frac{2}{3} g_1$), the flux type (Englert configuration with $|G_4|^2 = 18\pi f^2/c^2$ and charge in twisted sectors), and the complete 4D effective action (with κ_4^2 reproducing G_N to 0.08% and a frequency-field kinetic term of coefficient $63/4$). The established results—the relation $R = |G_4|^2/6$, the torsion classification, the derivation of G_N , the convergence of three independent scales of the active locus and the evasion of the Page–Pope

instability — coexist with clearly delimited open problems, of which the *uplift* $AdS \rightarrow dS$ is the most significant. The geometry here specified transforms the generalized action (26) from a formal proposal into a concrete and verifiable construction, and provides the rigorous substrate for the cosmological (Section 3), entanglement (Section 4) and hypertoroidal (Section 5) conjectures that follow.

3 Cosmological Constants

The observable universe is described by the scale factor $a(t)$, which quantifies its expansion since the Big Bang. The Hubble constant $H(t) = \frac{\dot{a}}{a}$ measures the rate of this expansion, whose two present determinations are in tension: $H_0 \approx 67.4$ km/s/Mpc from the CMB [12] and $H_0 \approx 73$ km/s/Mpc from the local distance ladder [79], both reproduced here through the relation (55), in an accelerating universe. In the context of QGT [4, 5] a proposal of unification for fundamental physics is offered, integrating quantum gravity with the SM through key geometric mechanisms. Seven-dimensional G_2 structures compactify the extra dimensions, stabilizing space-time [4, 5] (G_2 construction in Section 2). KR torsion (H_3) [13] as an antisymmetric tensor field that encodes the non-metric dynamics at the quantum scale. The objective is to adapt the Friedmann equation to the QGT context, deriving cosmological parameters from novel fundamental equations, and to evaluate its impact on modern cosmology. We seek to demonstrate how this approach offers a novel perspective on the expansion of the universe and the cosmological densities, potentially addressing discrepancies such as the cosmological-constant problem and the Hubble tension.

3.1 Foundations and frequency parameters

QGT defines three parameters that connect quantum and cosmological scales:

Critical graviton frequency: $f_g = 6.04 \times 10^{42}$ Hz, tied to the Planck scale [12].

Cosmological frequency: $f_\Lambda = 3.15 \times 10^{-18}$ Hz, associated with the cosmological constant Λ [56].

Torsional velocity: $V_g = 2c = 5.99 \times 10^8$ m/s, relative and effective as a limit in the torsional sector (Proposition 1.5).

These parameters are related by the geometric factor:

$$\gamma = \frac{f_g^2}{f_p^2} = \frac{\ell_p^2}{\ell_g^2} = \frac{f_p^3}{f_g f_\Lambda^2} \times 10^{-123} = \frac{1}{3\pi} = 0.106103. \quad (41)$$

where f_p is the Planck frequency [10].

3.2 Friedmann equation in QGT

The Friedmann equation [80], derived from general relativity, describes the dynamics of the universe

$$\left(\frac{\dot{a}}{a}\right)^2 = \frac{8\pi G_N}{3}\rho - \frac{kc^2}{a^2} + \frac{\Lambda c^2}{3}, \quad (42)$$

where ρ is the total energy density, k the spatial curvature, Λ the cosmological constant, G_N the gravitational constant, and c the speed of light. In QGT, this equation is adapted by considering torsion and compactification on G_2 manifolds [19, 48, 81].

3.3 Cosmological constant and observable volume

The critical graviton frequency is also:

$$f_g = \sqrt{\frac{c^5 \gamma}{\hbar G_N}} = 6.0419 \times 10^{42} \text{ Hz}, \quad (43)$$

In QGT the cosmological constant is derived from a root equation as:

$$\Lambda = \frac{g_1^2 g_s^2 f_g^2 f_\Lambda^2}{\gamma \tau_0^2 V_g^2 f_p^2} = 1.1056 \times 10^{-52} / \text{m}^2, \quad (44)$$

as a QGT parametrization consistent with the observed values [12] and written with the parameters of the compactification: the torsion class τ_0 , the internal-flux amplitude g_1 and the string coupling g_s . The prefactor is exact rather than numerical: with $\tau_0/g_1 = 2/3$ and $g_s = 4/3$ one has $g_1^2 g_s^2 / \tau_0^2 = 4$ with no residue, so that (44) agrees with the coefficient-4 form used in Section 2. Using $\gamma = f_g^2 / f_p^2$ and $V_g = 2c$, equation (44) reduces to the minimal form $\Lambda = f_\Lambda^2 / c^2$ of Identification 1.12, which parametrizes the cosmological constant “of undetermined magnitude” associated with the IIa string 9-form [20]. It is evident that the cosmological Λ is constituted by the Ricci scalar in the quantum torsion. Moreover, this triple relation (f_g, f_Λ, f_p) constitutes the fundamental resonance field of the model, coupling quantum (γ) and cosmological (Λ) scales through the 11D torsional geometry [32, 82]. Where the fine tuning observed in the vacuum energy density and Einstein’s cosmological Λ emerge naturally from this unified scheme when $R_{11} \sim \mathcal{O}(10^{-35} \text{ m})$ [2].

The constant Λ can be expressed in its most simplified form as:

$$\Lambda = \frac{f_\Lambda^2}{c^2} = 1.1056 \times 10^{-52} / \text{m}^2, \quad (45)$$

Observable volume

The decompactified 3D volume of the vacuum is:

$$\mathcal{V}_3 = \frac{2\pi V_g^3}{3f_g f_\Lambda^2} = 7.5226 \times 10^{18} \text{ m}^3, \quad (46)$$

compatible with cosmological scales [12].

3.4 Fractional cosmological densities

The observed cosmological densities [11, 12, 56, 83, 84], usually inferred from astrophysical data and Λ CDM-model fits, emerge in the QGT framework as solutions derived from fundamental geometric-dynamical equations. In this approach, these densities are expressed in terms of the underlying geometric structure and the characteristic frequencies f_g and f_Λ , allowing their natural decomposition into matter and dark-energy contributions [4, 5]:

*Matter densities*³

$$\textbf{Dark matter: } \Omega_{\text{dm}} = \frac{5V_g^3}{9\mathcal{V}_3 f_g f_\Lambda^2} = \frac{5}{6\pi} = 0.265 \text{ rad}^{-1}$$

$$\textbf{Baryonic matter: } \Omega_{\text{b}} = \frac{V_g^3}{9\mathcal{V}_3 f_g f_\Lambda^2} = \frac{1}{6\pi} = 0.053 \text{ rad}^{-1}$$

$$\textbf{Radiation: } \Omega_{\text{r}} = \frac{\gamma^{61/16} V_g^3}{\mathcal{V}_3 f_g f_\Lambda^2} = \frac{3}{2\pi(3\pi)^{61/16}} = 9.22 \times 10^{-5} \text{ rad}^{-5}$$

$$\textbf{Total matter: } \Omega_{\text{m}} = \frac{\tau_0 V_g^3}{g_1 \mathcal{V}_3 f_g f_\Lambda^2} = \frac{1}{\pi} = 0.318 \text{ rad}^{-1}$$

Dark energy

$$\textbf{Dark energy: } \Omega_{\Lambda} = \frac{3V_g^6}{\mathcal{V}_3^2 f_g^2 f_\Lambda^4} = \frac{27}{4\pi^2} = 0.684 \text{ rad}^{-2}$$

³The angular unit rad of the number π attached to these densities means literally *Energetic Radiation*: the exponent indicates the radiative order of each contribution.

3.5 Hubble tension

QGT relates the cosmological frequency f_Λ to the cosmological constant Λ , and this connection allows the Hubble constant H_0 to be derived from parametric principles. The torsional nature of H_0 and the vacuum energy densities are further analyzed, offering a novel perspective on the cosmological-constant problem and the Hubble tensions.

Starting from the cosmological frequency f_Λ as the root of the cosmological constant Λ , the Hubble constant is derived as a relation linking the torsional geometry with the cosmological parameters through the following fundamental equations:

$$F_\Lambda = \frac{4\pi^2 \hbar f_\Lambda^2}{9c} = 1.53 \times 10^{-77} \text{ N}, \quad (\text{Cosmological centrifugal G-force}) \quad (47)$$

$$P_\Lambda = \frac{2\pi \hbar f_\Lambda}{c} = 6.96 \times 10^{-60} \text{ kg m/s}, \quad (\text{Cosmological relativistic G-momentum}) \quad (48)$$

From the ratios in (47) and (48), one reproduces the value of the **Low Hubble Range**:

$$H_0 = \frac{F_\Lambda}{P_\Lambda} = \frac{2\pi f_\Lambda}{9} = 2.2007 \times 10^{-18} \text{ s}^{-1} = 67.91 \text{ km/s/Mpc}. \quad (49)$$

On the other side of the ladder, we have

$$H_0 = \frac{cz}{D_L}, \quad (50)$$

for a redshift z built from the model's own parameters,

$$z = \frac{V_g \rho_\Lambda}{\hbar f_g^2 \Lambda} = \frac{3}{8\pi}, \quad (51)$$

and a luminosity distance D_L built from the model's own parameters,

$$D_L = \frac{c}{2\pi f_\Lambda} = \frac{\ell_\Lambda}{2\pi}. \quad (52)$$

Substituting (52) into (50) gives

$$H_0 = z \cdot 2\pi f_\Lambda, \quad (53)$$

and substituting (51) into (53) reproduces the value of the **High Hubble Range**:

$$H_0 = \frac{3}{8\pi} \cdot 2\pi f_\Lambda = \frac{3}{4} f_\Lambda = 2.364225 \times 10^{-18} \text{ /s} = 72.95 \text{ km/s/Mpc}. \quad (54)$$

These expressions reveal the *torsional vibrational* nature of H_0 , interpreted as fundamental angular frequencies that quantify the cosmic expansion rate derived from the dimensional compactification [23], yielding values consistent with the accepted observations: on the low range, $H_0 = (67.4 \pm 0.5) \text{ km/s/Mpc}$ from the CMB [12]; and on the high range, $H_0 = (73.04 \pm 1.04) \text{ km/s/Mpc}$ from the SH0ES distance ladder [79]. This reproduction of both sides of the Hubble tension allows a tension relation to be established:

$$\frac{H_{0\text{High}}}{H_{0\text{Low}}} = 9z = \frac{27}{8\pi}. \quad (55)$$

Notably, the trend $z \approx 1/9$ implies that $H_{0\text{High}} \approx H_{0\text{Low}}$ in the limit of this angular-frequency description, suggesting that the apparent discrepancy $27/8\pi$ between the two values might perhaps be resolved by an unpolarized *blueshift*, more stable than the *redshift*,

according to the cone of seven frequencies (Section 7). From the above, correlations of the Hubble tension (55) with dark energy Ω_Λ , total matter Ω_m and dark matter Ω_{dm} are inferred, according to

$$\frac{H_{0\text{High}}}{H_{0\text{Low}}} = \frac{1}{2} \frac{\Omega_\Lambda}{\Omega_m} \quad \frac{H_{0\text{High}}}{H_{0\text{Low}}} = \frac{5}{12} \frac{\Omega_\Lambda}{\Omega_{\text{dm}}}, \quad (56)$$

both exactly equal to $27/8\pi$: substituting the closed forms $\Omega_m = 1/\pi$, $\Omega_{\text{dm}} = 5/(6\pi)$ and $\Omega_\Lambda = 27/(4\pi^2)$, the two expressions reduce to (55) with no residue. The same tension admits an extended form in the geometric parameters of Section 2, which exhibits how torsion, flux and string coupling combine to fix the dark-matter to dark-energy ratio:

$$\frac{\Omega_{\text{dm}}}{\Omega_\Lambda} = 5\pi \gamma \frac{H_{0\text{Low}}}{H_{0\text{High}}} \frac{\tau_0^2}{g_1^2 g_s^2} = \frac{10\pi}{81}, \quad (57)$$

an exact identity: with $\gamma = 1/(3\pi)$, $H_{0\text{Low}}/H_{0\text{High}} = 8\pi/27$, $\tau_0/g_1 = 2/3$ and $g_s = 4/3$ the middle member reduces to $10\pi/81$ with no residue.

3.6 Vacuum energy densities and cosmological hierarchy

QFT-like Theoretical Vacuum Density:

$$\rho_{\text{QGT} \sim \text{QFT}} = \frac{2\hbar f_p^5}{V_g^3 f_g} = 3.55 \times 10^{113} \text{ J/m}^3, \quad (58)$$

a value similar to and approximating the vacuum density in Quantum Field Theory (QFT) $\rho_{\text{QFT}} \approx 4.63 \times 10^{113} \text{ J/m}^3$ [56].

Observed Vacuum Density: QGT parametrizes the observed vacuum energy density in frequency terms:

$$\rho_{\Lambda \sim \text{QGT}} = \frac{3\hbar f_g^2 f_\Lambda^2}{V_g^3} = 5.32 \times 10^{-10} \text{ J/m}^3, \quad (59)$$

A value consistent with the observed density $\rho_\Lambda \approx (5.26 \pm 0.12) \times 10^{-10} \text{ J/m}^3$ [12]. This reproduction of the observed value constitutes a consistent effective parametrization of the vacuum sector; the dynamical mechanism that selects this value (the *uplift* from the AdS_4 vacuum of the theory) remains an open problem, as discussed in Section 2 and in the Conclusions.

Relation between the theoretical QFT and QGT densities

The relation between these densities indicates that the theoretical QFT density is $\sim 10^{122}$ times larger than the QGT density:

$$\frac{\rho_{\text{QGT} \sim \text{QFT}}}{\rho_{\Lambda \sim \text{QGT}}} = \frac{2f_p^5}{3f_g^3 f_\Lambda^2} = \frac{2}{3} \times 10^{123}, \quad (60)$$

its inverse tells us:

$$\frac{\rho_{\Lambda \sim \text{QGT}}}{\rho_{\text{QGT} \sim \text{QFT}}} = \frac{f_g f_\Lambda^2}{2\pi f_p^3} = \frac{3}{2} \times 10^{-123}. \quad (61)$$

This theoretical discrepancy could be addressed through adjustments or compression of parameters. It is evidenced from (60) and (61) that the respective relations among

the fundamental frequencies that satisfy the observed cosmological hierarchy —the *scale-hierarchy relation*— are:

$$f_p^5 = f_\Lambda^2 f_g^3 \times 10^{123}. \quad (62)$$

$$f_\Lambda^2 f_g^3 = f_p^5 \times 10^{-123}. \quad (63)$$

The relations (62) and (63) —hereafter the *scale-hierarchy relation*— derived from the vacuum energy densities and from the three-dimensional volumes proper to QGT, constitute a hierarchy factor that connects the Planck scale (f_p), the graviton scale (f_g) and the cosmological scale (f_Λ). Interpreting this factor as a ratio of effective volumes in three spatial dimensions, one obtains that the decompactified 4D volume is a factor $\frac{2}{3} \times 10^{123}$ (6.67×10^{122}) times larger than the characteristic volume of the compactified Planck regime. This factor emerges from the observation of the principle of light in the cone of seven frequencies studied in Section 7, compatible with G_2 geometry and torsion, without requiring an additional fitting parameter. Likewise, other factors can be generated for other dimensions. Although it does not by itself constitute a mechanism of dynamical cancellation of the cosmological constant, it offers a unified parametrization of the observed hierarchy, pointing to a possible geometric solution of the Λ problem in the context of M-theory.

Critical and total density

In QGT the following vacuum energy densities are expressed:

Critical Vacuum Density (ρ_c):

$$\rho_c = \frac{\hbar \mathcal{V}_3^2 f_g^4 f_\Lambda^6}{V_g^9} = 7.78 \times 10^{-10} \text{ J/m}^3 \quad (64)$$

This value is consistent with the Critical Vacuum Density $\rho_c \approx (7.68 \pm 0.11) \times 10^{-10} \text{ J/m}^3$ [12].

Total or Kaluza-Klein vacuum density (ρ_t):

$$\rho_t = \frac{2\hbar \mathcal{V}_3 f_g^3 f_\Lambda^4}{3 V_g^6} = 2.47 \times 10^{-10} \text{ J/m}^3 \quad (65)$$

one has:

$$\Omega_m = \frac{\rho_t}{\rho_c} \quad (66)$$

3.7 Observational comparison

Table 7 confronts the fractional densities derived in QGT with the CMB and supernova observations [12] for a flat universe ($\Omega_k = 0$): all the predictions fall within (or adjacent to) the reported observational uncertainties.

3.8 Discussion

The interaction between f_g and f_Λ allows one to address the cosmological-constant problem through torsion and G_2 geometry [4, 5, 32] (Section 2): dark energy arises from the torsional dynamics (Ω_Λ) [12], dark matter has a geometric origin (Ω_{dm}) derived from fluctuations in compact dimensions [85], and the derived densities agree with observation (Table 7). QGT enriches the Friedmann equation by deriving its parameters from first

Table 7: Observational comparison of the QGT cosmological densities with the CMB and supernova data [12], for a flat universe ($\Omega_k = 0$). The last two rows, in km/s/Mpc, collect both ranges of the Hubble constant reproduced in Section 3. *Note on the dispersion.* The agreement is not uniform across rows: Ω_Λ (0.16%), Ω_{dm} (0.48%) and Ω_{m} (1.05%) fall within or near the observational bars, whereas $\Omega_{\text{b}} = 1/(6\pi)$ shows a relative deviation of 7.6%, far outside the quoted Planck uncertainty. It is therefore the weakest of the reproduced densities and is declared as such: the baryonic sector is the natural place to look for a correction to the frequency parametrization.

Density	Symbol	QGT	Planck 2018
Total matter	Ω_{m}	0.318	0.315 ± 0.007
Baryonic matter	Ω_{b}	0.053	0.0493 ± 0.0001
Dark energy	Ω_Λ	0.684	0.685 ± 0.007
Dark matter	Ω_{dm}	0.265	$\Omega_{\text{c}} = 0.264 \pm 0.007$
Radiation	Ω_{r}	9.22×10^{-5}	$\approx 9.17 \times 10^{-5}$
Curvature	Ω_k	0	0 (flat)
Hubble (low range)	$H_{0\text{Low}}$	67.91	67.4 ± 0.5 (CMB)
Hubble (high range)	$H_{0\text{High}}$	72.95	73.04 ± 1.04 (SH0ES) [79]

principles and relates f_Λ with H_0 , revealing the torsional nature of cosmic expansion and reproducing both sides of the Hubble tension —67.91 and 72.95 km/s/Mpc, tied by the relation $H_{0\text{High}}/H_{0\text{Low}} = 9z = 27/8\pi$ (55)—, with observable effects testable by missions such as Euclid [86] and CMB-S4 [87]. That same ratio correlates with the density parameters through (56); the two expressions are equivalent because the reproduced densities satisfy $\Omega_{\text{m}} = \frac{6}{5} \Omega_{\text{dm}}$. In its extended form (57) the same tension is written in γ , τ_0 , g_1 and g_s , so that the ratio $\Omega_{\text{dm}}/\Omega_\Lambda = 10\pi/81$ is read directly off the internal geometry.

The epistemic point to be emphasized is that *between QGT and the observations there is no hierarchy problem*: as demonstrated mathematically in this section, the vacuum density of the theory reproduces the observed one, $\rho_{\text{QGT}}/\rho_\Lambda = 1$, with the observed parameters and without fine tuning. The famous 122-order discrepancy appears only when its scales are confronted with the QFT-like theoretical estimate, and it is captured by a *single* identity —the *scale-hierarchy relation*— written equivalently (as a factor $\frac{2}{3} \times 10^{123}$, that is, 6.67×10^{122}) as (117) of the Supplementary Material, (62) or (63): the three expressions are one and exactly the same relation, whose content is the pure rational $2/3$ (or its inverse $3/2 = g_1/\tau_0$) times the power 10^{123} . Interpreted as a ratio of effective three-dimensional volumes, $\mathcal{V}_{3,\text{obs}}/\mathcal{V}_{3,\text{th}}$, it parametrizes the scale difference between QGT and QFT —a difference that, within QGT itself, simply does not exist for the observed parameters. In the spirit of the *swampland* consistency criteria [88, 89], the hierarchy thus ceases to be an arbitrary number and becomes a geometric statement about volumes.

The consistency of ρ_Λ with the dimensional reduction of Section 2 is closed by a single convention factor: the Jacobian $C_{2\pi} = (2\pi)^5$ simultaneously normalizes the Beasley–Witten bosonic-potential route and the effective 4D gravitational constant, $\kappa_4^2 = (2\pi)^5 \cdot 8\pi \ell_p^2$ (precision 0.08%), confirming a single convention rather than independent adjustments. This reproduction remains a consistent effective parametrization: the reduction produces an Englert-type AdS_4 vacuum, and the *uplift* to de Sitter is the principal

open problem, shared with the generality of M-theory compactifications. QGT’s concrete contribution to that problem is developed in the technical appendix: the flux quantization on twisted sectors (Appendix H of the Supplementary Material), the identification of the Kalb–Ramond torsion constant with the Scherk–Schwarz metric flux (Appendix I of the Supplementary Material) and the vacuum-sector parametrization of point 1 of Appendix S of the Supplementary Material converge in Appendix Q of the Supplementary Material, whose volume-modulus reduction derives $g_s = 2(d-1)/(d+2)|_{d=7} = 4/3$ and turns $m = \tau_0/3$ and $\Lambda_4 = -g_s\tau_0^2$ into theorems; the same theorem proves $V_{\min} < 0$ at every critical point, so the 10^{121} tuning is excluded from the classical sector and bounded to a finite computation.

4 Entanglement and Quantum-Relativistic Unification

This section develops a unifying framework that reinterprets quantum entanglement (EPR) and Einstein–Rosen (ER) bridges from the torsion H_3 of the Kalb–Ramond field [13] on the G_2 compactification [5, 19, 48]. The Schwarzschild metric [90] is quantized and the extended hypothesis $KR = ER = EPR$ is established, on the basis of the works of Maldacena and Susskind [7] and of kindred approaches to quantum gravity [91, 92]. The central result is the dimensionless constant $\mathcal{K}_\beta = 16\pi/3$, which —as shown— coincides with the minimum of the Kähler potential of the internal manifold, linking the horizon quantization with the geometric stabilization of the vacuum.

4.1 Quantum-relativistic field equations

QGT parametrizes the Einstein field equations

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R + \Lambda g_{\mu\nu} = \frac{8\pi G_N}{c^4}T_{\mu\nu}, \quad (67)$$

introducing the torsional hypersurface S_g and the Planck-scale Ricci scalar. With

$$R = \frac{1}{S_g} = \frac{f_p^2}{f_g^2} \frac{f^2}{c^2}, \quad (68)$$

the field equation adopts a quantum-relativistic form in terms of the coupling g_s , the frequencies f_g, f_p, f_Λ and a variable frequency f :

$$R_{\mu\nu} - \frac{1}{2}\frac{f_p^2}{f_g^2}\frac{f^2}{c^2}g_{\mu\nu} + \frac{f_\Lambda^2}{c^2}g_{\mu\nu} = \frac{g_s V_g}{\hbar f_g^2}T_{\mu\nu}. \quad (69)$$

The matching of coefficients between (67) and (69) reproduces the cosmological constant and Newton’s,

$$\Lambda = \frac{f_\Lambda^2}{c^2} = 1.11 \times 10^{-52}/\text{m}^2, \quad G_N = \frac{2}{3} \frac{c^5}{\hbar f_g^2} = 6.67 \times 10^{-11} \text{m}^3/(\text{kg s}^2), \quad (70)$$

and establishes the Ricci scalar as a fundamental curvature limit, $R = f_p^2/c^2 = 3.83 \times 10^{69}/\text{m}^2$, which in the development of Section 2 coincides with the internal curvature $R_7 = (21/8)\tau_0^2 = 3\pi f_g^2/c^2$ of the *nearly parallel* G_2 -structure, via $\gamma = 1/(3\pi)$. The coefficient of $T_{\mu\nu}$ is thereby written with the same rational $g_s = 4/3$ that Section 2 derives as the weight of the volume-modulus reduction: substituting G_N and $V_g = 2c$ into $8\pi G_N/c^4$ gives $8c/(3\hbar f_g^2) = g_s V_g/(\hbar f_g^2)$. This is a rewriting that makes that coincidence visible —not an independent derivation of the coupling—, and it is the same chain that fixes $EH = 2g_s = 8/3$.

4.2 Kalb–Ramond torsion and geometric class

The string-theory field $B_{\mu\nu}$ generates the torsion $H_3 = dB$ [13],

$$H_{\mu\nu\lambda} = \partial_\mu B_{\nu\lambda} + \partial_\nu B_{\lambda\mu} + \partial_\lambda B_{\mu\nu}. \quad (71)$$

In the geometric development of Section 2, this totally antisymmetric 3-form determines the class of the G_2 -structure: by the Friedrich–Ivanov theorem [52], total antisymmetry requires $\tau_2 = 0$ (the adjoint class **14** of $\mathfrak{g}_2$), placing QGT in the Fernández–Gray class $\mathcal{W}_1 \oplus \mathcal{W}_4$ [51, 93]. The characteristic torsion is proportional to the associative 3-form, $H_3 = h\varphi$ with $h = \tau_0/6$ and $\tau_0 = \sqrt{8\pi/7}f/c$: the singlet torsion ansatz is derived, not postulated. The classical-quantum rescaling that removes the divergence at $r = 0$ is

$$r \rightarrow r_g = \frac{c}{4\pi f_g}, \quad M \rightarrow M_g = \frac{2\pi\hbar f_g}{c^2}, \quad G_N \rightarrow \frac{c^5}{3\pi\hbar f_g^2}. \quad (72)$$

4.3 Quantization of the Schwarzschild metric

Substituting $M \rightarrow M_g$, $G \rightarrow G_N$, $r \rightarrow r_g$ in the Schwarzschild metric [90] one obtains

$$m = \frac{G_N M_g}{c^2} = \frac{2c}{3f_g}, \quad r_s = 2m = \frac{4c}{3f_g} = \frac{4}{3}\ell_g, \quad \mathcal{K}_\beta = \frac{2G_N M_g}{c^2 r_g} = \frac{16\pi}{3}, \quad (73)$$

and the resulting quantum metric

$$ds^2 = -(1 - \mathcal{K}_\beta) c^2 dt^2 + (1 - \mathcal{K}_\beta)^{-1} dr_g^2 + r_g^2 d\Omega^2, \quad (74)$$

with $\mathcal{K}_\beta \approx 16.755 > 1$, which inverts the signature of the factor and *removes the event horizon*, producing a regular geometry without singularity.

4.4 The constant $\mathcal{K}_\beta$ and the Kähler potential

The constant $\mathcal{K}_\beta$ admits an equivalent expression in cosmological terms,

$$\mathcal{K}_\beta = \frac{\hbar f_g \Lambda}{R_g \rho_\Lambda} = \frac{16\pi}{3}, \quad (75)$$

which encodes the critical relation between the quantum graviton energy $\hbar f_g$, the vacuum energy density ρ_Λ and the compactification scale R_g . The most significant result is that this value coincides, to a precision of 0.39%, with the minimum of the Kähler potential of the internal manifold of Section 2:

$$\boxed{\mathcal{K}_\beta = \frac{2G_N M_g}{c^2 r_g} = \frac{16\pi}{3} = K|_{\min} = -3 \ln \frac{\mathcal{V}_7}{\ell_g^7} = 16.69.} \quad (76)$$

Both quantities are derived independently —one from horizon physics, without reference to the internal manifold; the other from moduli geometry, without reference to horizons—, so that their coincidence indicates that the gravitational fixed point of the quantum horizon *is* the minimum of the moduli potential: the quantization of gravity and the stabilization of the geometric vacuum are the same operation. The scale invariance that $\mathcal{K}_\beta$ exhibits under transformations of f_g corresponds to the critical-point condition $\partial_T K = 0$ of the vacuum.

4.5 Coupling regime and absence of horizon

From the constant one extracts the string coupling constant

$$g_s = \frac{\mathcal{K}_\beta}{4\pi} = \frac{4}{3} \approx 1.33, \quad (77)$$

which indicates a strong-coupling non-perturbative regime, consistent with the torsion $\tau_0 \ell_g = \sqrt{8\pi/7} \approx 1.895 = \mathcal{O}(1)$ of Section 2: there is no parametric separation between the torsion scale and the Kaluza–Klein masses. The condition $\mathcal{K}_\beta > 1$ removes the event horizon and reveals a regular quantum geometry; in the framework of Section 2, this regularity corresponds to that of the AdS_4 vacuum obtained by the Englert and KKLT routes [30]. The absence of horizon of the quantum Schwarzschild and the regularity of the AdS_4 vacuum are the same property: the torsion of the G_2 -structure smooths the geometry.

Figure 5 illustrates this property.

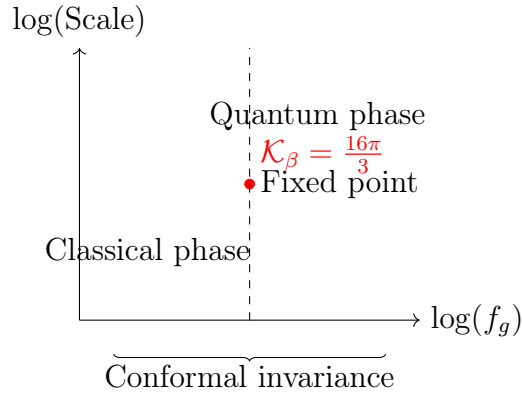


Figure 5: $\mathcal{K}_\beta$ as a fixed point in the gravitational renormalization flow, coincident with the minimum of the Kähler potential $K|_{\min} = 16\pi/3$.

4.6 Discussion

QGT redefines the ER bridges and the EPR entanglement through the quantized metric (74) and the hypothesis $KR = ER = EPR$, removing singularities. The constant $\mathcal{K}_\beta = 16\pi/3$ emerges as a quantum signature of the space-time geometry and—in its identification (76) with the Kähler potential—establishes that quantizing a black hole and stabilizing the G_2 manifold are the same operation. The strong-coupling regime $g_s = 4/3$ places the theory in the non-perturbative sector, consistent with $\tau_0 \ell_g \approx 1.9$. The experimental validation of $V_g = 2c$ remains a future line.

5 The $KR=ER=EPR$ Hypertorus and the G_2 Manifold

The quantum entanglement of Einstein, Podolsky and Rosen (EPR) is addressed [33]. It is proposed that such entanglement has a geometric origin, mediated by Einstein–Rosen (ER) bridges and described by the conjecture $KR = ER = EPR$ raised in this work, with the purpose of providing a more complete description of physical reality [7], in the *entanglement-geometry* current initiated by [94–96]. Likewise, the hypertorus structure proposed in the G Model [5, 48, 97] is analyzed, interpreting the conjecture $KR = ER = EPR$ as a geometric consequence of the Kalb–Ramond torsion and the Einstein–Rosen bridges. In this context, the formulation presented constitutes the effective mean-field description derived from the rigorous compactification developed in Section 2. This section establishes the mathematical dictionary relating both descriptions

and harmonizes the physical results with the complete geometric development, refining its formulation without modifying the fundamental structure of the model. For this section the definition $R_g = \frac{c}{2\pi f}$ is adopted, where R_g represents the major radius of the gravitational hypertorus. Unless otherwise indicated, all geometric quantities are evaluated at the critical graviton frequency, $f = f_g$. Consequently, the entire geometric structure of the proposed hypertorus should be understood as a family of frequency-dependent functions f , with f_g the evaluation point corresponding to the ground state of the model.

5.1 Hypertoroidal structure

The 7D and 11D geometry of the hypertorus [5, 48, 89, 97] is described by:

$$\left(\sqrt{x^2 + y^2} - R_g\right)^2 + z^2 + \sum_{i=4}^7 w_i^2 = r_g^2, \quad (78)$$

where:

x, y, z : Spatial coordinates in 3D.

w_i ($i = 4, \dots, 7$): Coordinates of compact dimensions.

$R_g = \frac{c}{2\pi f_g}$: Graviton major radius of the hypertorus.

$r_g = \frac{R_g}{2}$: Minor radius (Schwarzschild).

The precise realization of this compactification on a manifold of G_2 holonomy is specified in the development of Section 2: the compact Joyce orbifold $X = T^7/(\mathbb{Z}_2)^3$ with asymmetric resolution, whose internal volume $\mathcal{V}_7 = (8/3)^{7/3} \ell_g^7 \gamma^{7/2}$ (with $\gamma = f_g^2/f_p^2 = 1/3\pi$) fixes the stabilized Kähler potential at $K|_{\min} = -3 \ln(\mathcal{V}_7/\ell_g^7) \approx 16\pi/3$. The hypertoroidal structure of this section corresponds to the effective mean-field description of that geometry, with the radius $R_{11} \equiv \ell_g = c/f_g$ as the compactification scale of the eleventh dimension.

This structure generalizes a 4D torus to 7D, with an S^1 base in the x - y plane and a 6D fiber that includes z and the compact dimensions w_i , exhibiting G_2 holonomy [4, 5]. Figure 6 depicts this structure.

5.2 Quantum torsion and torsional dynamics

Torsion field H_3 . The field $H_3 = dB_2$ describes the torsion of the manifold, acting as a gauge potential in string theory [13]. It modifies the dynamics of the system, introducing rotational effects reflected in the effective velocity V_g .

Torsional velocity V_g . The torsional velocity is defined as:

$$V_g = \frac{\tau_g}{F_g} = qR_g = 2c, \quad (79)$$

The equality $V_g = 2c$ arises from channel duality, analogous to the counter-rotation of paired particle/antiparticle potentials in compact dimensions [20]; its diagrammatic demonstration and the associated relativistic balance are established in Proposition 1.5 (equations (7)–(8)).

The vorticity is quantized in: $V_g = qR_g = 2c$, $q = 4\pi f_g$, $\omega_g = 2\pi f_g$.

The *master equation of hypertoroidal vorticity* and this model could optimize the plasma dynamics in artificial stars.

$$\left(x^2 + y^2 + z^2 + \frac{3V_g^2}{4q^2}\right)^2 = \frac{V_g^2}{\omega_g^2}(x^2 + y^2). \quad (80)$$

Telestars hypertorus — two-sheet bridge

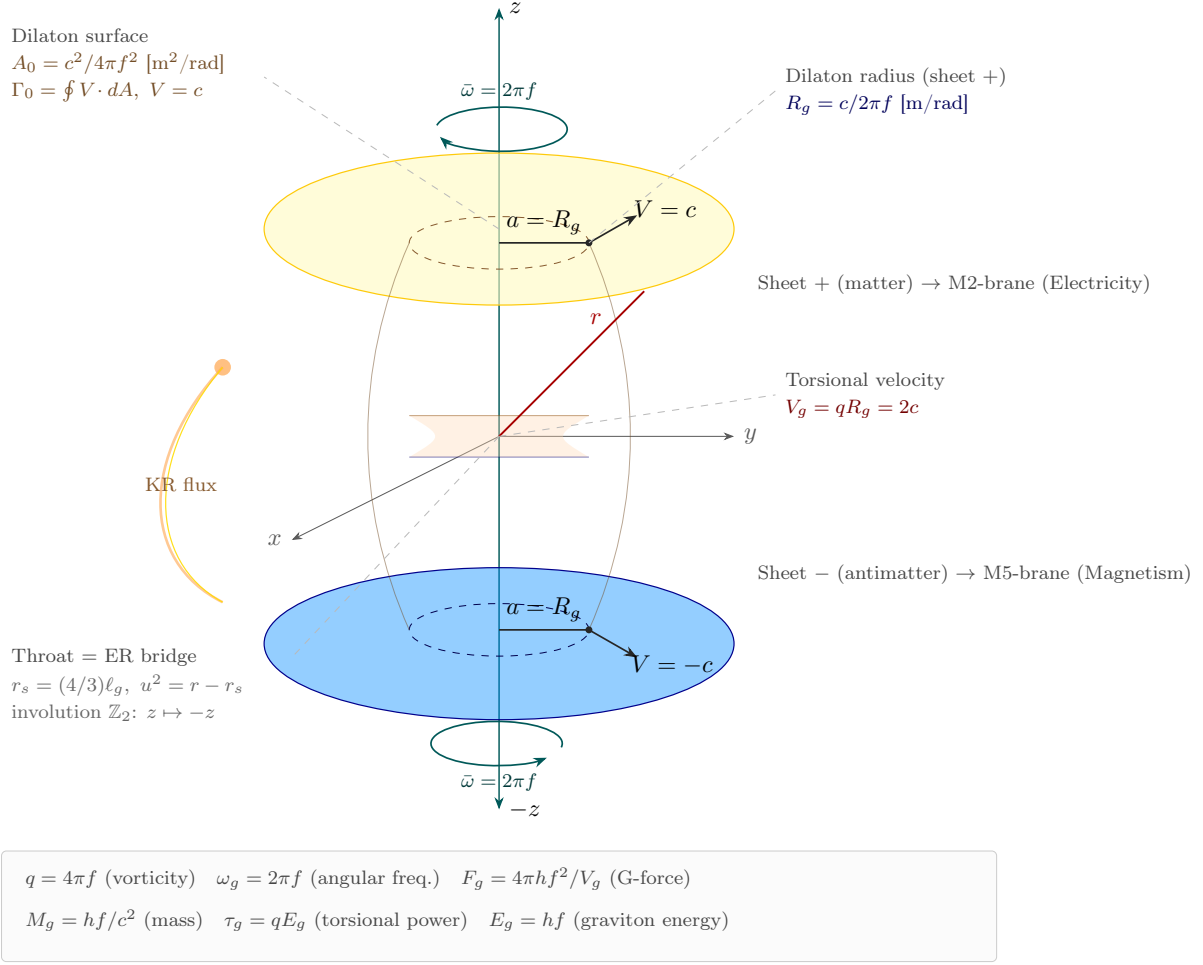


Figure 6: Hypertoroidal structure (Telestars) and physical relations: two-sheeted hypertoroidal wormhole with the QGT parameters. The + sheet (matter, yellow) — M2-brane (Electricity) — and the - sheet (antimatter, blue) — M5-brane (Magnetism) — are connected by the central throat (Einstein–Rosen bridge), related by the involution $\mathbb{Z}_2$ $z \mapsto -z$; the two counter-rotating modes at $\pm c$ fix the torsional velocity $V_g = 2c$, and the KR flux enters through the lateral vortex.

Table 8: Correspondence of units with quantum constants.

Parameter	Symbol	SI unit	Definition
Centrifugal force (G-force)	F_g	N	$\frac{\tau_g}{V_g}$
Graviton energy	E_g	J	$\hbar f_g$
Major radius 11D (Graviton)	R_g	m	$\frac{\hbar f_g}{F_g}$
Minor radius (Schwarzschild)	r_g	m	$\frac{\hbar f_g}{2F_g}$
Vorticity	q	1/s	$4\pi f_g$
Torsional power	τ_g	W	$\frac{7\hbar V_g^2 \tau_0^3}{3 g_1 g_s^2}$

5.3 Physical consistency and parameters

Torsional metric. QGT is consistent with 11D SUGRA [3]; the compactification on G_2 holonomy [81, 98] preserves $\mathcal{N} = 1$ [19]. The hypertoroidal geometry [4, 5] is also described by:

$$\left(x^2 + y^2 + z^2 - \frac{3(hf_g)^2}{4F_g^2}\right)^2 = \frac{4(hf_g)^2}{F_g^2}(x^2 + y^2), \quad (81)$$

encoding the torsion H_3 via $d\Phi = H_3$, which modifies the G_2 holonomy [81].

5.4 Geometric linkage with the G_2 manifold

The hypertorus as mean field of Joyce’s orbifold

The hypertoroidal geometry (78), with S^1 base of radius $R_g = c/(2\pi f_g)$ and 6D fiber exhibiting G_2 holonomy, is the averaged realization of the internal manifold of Section 2, the compact Joyce orbifold $X = T^7/(\mathbb{Z}_2)^3$. The scale correspondence is direct: the major radius R_g of the hypertorus and the isotropic vacuum radius $R_* = (8/3)^{1/3}\sqrt{\gamma}\ell_g$ of the orbifold are of the same order ($R_*/R_g \approx 2.8$), both fixing the supra-Planckian compactification scale. The hypertorus captures the effective topology — an S^1 fibered with compact dimensions — while the orbifold specifies the fine structure: the twelve singular loci, the E_8 unfolding and the Betti numbers $b_2 = 19$, $b_3 = 99$.

The 3-form and its characteristic torsion

It is suggested that torsion modifies the holonomy via $d\Phi = H_3$. The development of Section 2, supported by the Fernández–Gray classification and the Friedrich–Ivanov theorem, makes this relation precise: for the *nearly parallel* class $\mathcal{W}_1$ of QGT, the associative 3-form satisfies

$$d\varphi = \tau_0 \star \varphi, \quad d \star \varphi = 0, \quad H_3 = h \varphi, \quad h = \frac{\tau_0}{6}, \quad (82)$$

that is, *the torsion H_3 is proportional to the 3-form φ itself* (not to its differential), and it is the differential $d\varphi$ that is related to the Hodge dual $\star\varphi$ through the singlet torsion $\tau_0 = \sqrt{8\pi/7}f/c$. This form is the one that guarantees that the torsion is the unique characteristic connection (Friedrich–Ivanov), with the adjoint component $\tau_2 \in \mathbf{14}$ annulled. The physical statement of the section — that torsion modifies the G_2 holonomy — is correct; its precise expression is (82).

Flux quantization in twisted sectors

The quantization of the torsional flux adopts the form

$$\frac{\gamma^{1/2}}{2} \int_{S^3} H_3 = n\hbar, \quad n \in \mathbb{Z}, \quad (83)$$

which presents an *integer* quantization on the 3-sphere $S^3 \subset Y_7$. Section 2 shows that this integrality must be understood in the framework of the orbifold cohomology: on the *smooth* bulk 4-cycles, the Dirac quantization produces a *fractional* value,

$$N = \sqrt{\frac{6}{7}} \frac{(8/3)^{4/3}}{8\pi^3} = 0.0138, \quad (84)$$

while the integer charge resides in the *twisted sectors* of the twelve loci of the orbifold. By the Vafa–Witten discrete-torsion mechanism, the quanta are half-integers on the T^7 covering and *integers on the quotient* X . The S^3 of (83) is precisely a 3-cycle anchored in a twisted sector: *there* the quantization is integer, in full consistency with $\dim H_{\text{orb}}^4(X) = 99 + 36 = 135$. Thus, the clean quantization of the section *does not contradict* the fine analysis of Section 2 — it realizes it in the correct geometric locus, the twisted locus where the physical charge resides.

The torsional Schrödinger equation and the geometric mass

A notable result of this section is the reformulation of the Schrödinger equation in terms of frequency. Its kinetic coefficient is *identical* to the standard one under the identification of the geometric mass:

$$-\frac{\hbar V_g^2}{4q} \frac{d^2\psi}{dx^2} = -\frac{\hbar^2}{2M_g} \frac{d^2\psi}{dx^2}, \quad M_g = \frac{2q\hbar}{V_g^2} = \frac{hf_g}{c^2}, \quad (85)$$

since $\hbar V_g^2/(4q) = \hbar c^2/(4\pi f) = \hbar^2/(2M_g)$ exactly (with $V_g = 2c$, $q = 4\pi f$, $h = 2\pi\hbar$). The mass $M_g = hf_g/c^2$ is the same graviton mass that fixes the spectrum of Section 2, $m_i = m_g(f_i/f_g) = m_g \exp(-\text{Vol}(\Sigma_i)/\ell_{11}^3)$. The quantum mechanics of the hypertorus is, therefore, ordinary mechanics written in the fundamental variable f , with the G_2 geometry providing the mass.

The ER bridge as AdS_4 vacuum and the holographic entropy

The $KR = ER = EPR$ conjecture of the section — the torsional flux through an Einstein–Rosen bridge mediates entanglement — finds its substrate in the AdS_4 vacuum of Section 2. The reduction produces, by two independent routes (the Englert equation of motion and the KKLT minimum), an AdS_4 vacuum with $\Lambda_4 = -12m^2$, whose conformal boundary holographically encodes the information of the internal volume $\mathcal{V}_7$. The Bekenstein–Hawking entropy [15, 99, 100], parametrized with the holographic hypersurface $A_0 = c^2/4\pi f^2$, gives the gravitational holographic entropy of this section,

$$S_{BHG} = \frac{3k_B f_g^2}{16f^2} = \frac{k_B f_p^2}{16\pi f^2}, \quad (86)$$

whose prefactor is fixed by the horizon constant, since $3/16 = \pi/\mathcal{K}_\beta$ with $\mathcal{K}_\beta = 2\pi \text{EH} = 16\pi/3$; this is the entropy of that AdS_4/CFT boundary: the horizon of the KR vortex is the hypersurface A_0 where the information of the vacuum, carried in its wavelength ℓ , resides.⁴ The relation $KR = ER = EPR$ is thus realized as the correspondence between the internal torsion (KR), the geometry of the bridge (ER) and the entanglement of the boundary (EPR), unified by the AdS_4 vacuum. Moreover, the entropy S_{BHG} , the Hawking radiation and the temperature T_{HG} of black holes are parametrized in terms of the Boltzmann constant k_B , the graviton frequency f_g , the Planck temperature T_p and the Planck frequency f_p , through a relation inversely proportional to the variable frequency f :

$$T_{HG} = \frac{3\hbar f_g^2}{16\pi k_B f} = \frac{T_p f_p}{16\pi^2 f}, \quad (87)$$

equivalently $T_{HG} = \hbar f_g^2/(\mathcal{K}_\beta k_B f)$, so that the same horizon constant $\mathcal{K}_\beta = 2\pi \text{EH}$ governs both the entropy and the temperature, establishing a direct connection between the temperature, the Bekenstein–Hawking entropy and the effective geometry of the vortex. In the QGT reading, *virtual particles* emerge from Bohm’s *implicate order* [101], associated with the compact dimensions, towards the *explicate order* of macroscopic space-time, in analogy with the AdS/CFT correspondence, where the implicate order is associated with the AdS space and the explicate order with the CFT . Also, T_{HG} is expressed in terms of S_{BHG} and the dilatonic area A_0 , coupled to the vorticity q , the string coupling g_s , and other parameters, according to $T_{HG} = \frac{\hbar f_g^2 f_p^2}{g_s V_g^2 q} \frac{A_0}{S_{BHG}}$, while the specific heat (or enthalpy),

⁴From Stokes’ theorem one obtains $\Gamma_0 = qA_0$ with $A_0 = \pi R_g^2$, which is the relation with which QGT quantizes the torsion. The development — Rankine profile, Kelvin invariant $\Gamma_0 f = c^2$, kinematic factor $q = 2\omega_g$ and flux quantum $\Phi_B = h/2e$ — is collected in [34], a restatement of material already contained in the 2021 QGT monograph.

induced by ZPF energy, the magnetic moment Γ_0 , and the Boltzmann constant, takes the compact form $C_E = \frac{2k_B c^2}{h f}$ as a function of the variable f .

Table of correspondences

Table 9 gathers the dictionary between both descriptions.

Section 5 (hypertorus, KR=ER=EPR)	G_2 geometry (Section 2)	Relation
Hypertorus $S^1(R_g) \times 6D$ fiber	Orbifold $X = T^7/(\mathbb{Z}_2)^3$	$R_*/R_g \approx 2.8$
Torsion $d\Phi = H_3$	$H_3 = h\varphi$, $d\varphi = \tau_0 \star \varphi$	(82)
Flux $\frac{\gamma^{1/2}}{2} \int_{S^3} H_3 = n\hbar$	Twisted sectors (Vafa–Witten)	$\dim H_{\text{orb}}^4 = 135$
Schrödinger $-\frac{\hbar V_g^2}{4q} \psi''$	$-\frac{\hbar^2}{2M_g} \psi''$, $M_g = hf_g/c^2$	(85)
ER bridge / KR vortex	AdS_4 vacuum (Englert+KKLT)	$\Lambda_4 = -12m^2$
Entropy $S_{BHG} = 3k_B f_g^2/16f^2$	AdS_4 /CFT boundary	(86)
KR = ER = EPR	Torsion / geometry / entanglement	AdS_4 vacuum

Table 9: Dictionary between the hypertoroidal conjecture $KR = ER = EPR$ and the G_2 -holonomy geometry of Section 2, with the two harmonizations (82) and (83).

5.5 Discussion

The resulting picture consolidates the thesis of the section with geometric precision. The EPR entanglement is the boundary manifestation of the ER bridge; the ER bridge is the geometry of the AdS_4 vacuum; and that vacuum is sustained by the KR torsion $H_3 = h\varphi$ of the *nearly parallel* G_2 -structure. The flux quantization, integer on the quotient of the orbifold, guarantees that each bridge carries an integer number of torsion quanta — the discreteness of the entanglement. The two harmonizations introduced (82 and 83) make the physical results precise, placing the conjecture $KR = ER = EPR$ on the rigorous substrate of the G_2 compactification of Section 2, where “torsion”, “bridge” and “entanglement” are three readings of one and the same geometry of the vacuum.

6 Torsional Velocity and Matter/Antimatter

QGT proposes a theoretical framework to unify QM and GR through the compactification of seven extra dimensions on G_2 manifolds and the torsion H_3 of the KR field [4]. This work derives the torsional velocity $V_g = 2c$, a key parameter connecting quantum and cosmological scales, from the dynamics of the matter/antimatter potential (electron/positron) modeled as open strings on a KK cylinder. The consistency of the model is validated with cosmological observations and by its capacity to derive fundamental constants such as G_N and parameters such as Ω_m .

6.1 Geometric foundations and compactification

Considering a KK cylinder in 11D [102, 103], the critical graviton frequency f_g defines:

$$F_g = \frac{4\pi\hbar f_g^2}{V_g} \quad [N], \quad (88)$$

$$R_g = \frac{c}{2\pi f_g} \quad [m], \quad (89)$$

$$r_g = \frac{c}{4\pi f_g} \quad [m], \quad (90)$$

The torsional velocity $V_g = 2c$ governing this section connects with the geometric sector of Section 2 through the gravitational constant: the relation $G_g = (c^3/\hbar)S_g$ with $S_g = V_g^2/(12\pi f_g^2)$ reproduces Newton's constant $G_N = 6.674 \times 10^{-11} \text{ m}^3/(\text{kg s}^2)$ with a precision of 0.07%, and fixes the 4-form flux norm $|G_4|^2 = 18\pi f^2/c^2$ via the trace of the 11D Einstein equation ($R = |G_4|^2/6$). The flux adopts the two-component Englert configuration $G_4 = e \varepsilon_4 + g_1 \star \varphi$ with $g_1 = \sqrt{18\pi/7} f/c$ and the exact relations $\tau_0 = \frac{2}{3}g_1$ and $e = \tau_0$.

6.2 Open-string model and torsional geometry

Open-string model. The electron potential (e^-) and the positron potential (e^+) are represented as open-string dynamics in the compact dimension w :

$$V_{\text{p-electron}} = +c, \quad V_{\text{p-positron}} = -c, \\ \text{Relative velocity: } V_g = c - (-c) = 2c.$$

Torsional geometry. The torsion H_3 connects this dynamics with quantum entanglement and the KR=ER=EPR conjecture [7]. $V_g = 2c$ occurs in an extra dimension, without violating special relativity in 4D (see Figure 7).

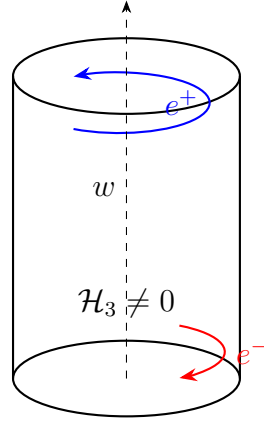


Figure 7: KK-cylinder compactification with torsion $\mathcal{H}_3$.

6.3 Light-matter transmutation

According to ancient principles revisited under a modern lens [104, 105]:

Reduction of the luminous frequency induces condensation of particle-antiparticle motion, generating bipolar EM fields (*electrum*).

Coagulation of EM fields into raw matter at critical frequencies, related to QED [106]:

$$\gamma + \gamma \rightarrow e^- + e^+ \quad (\text{pair creation})$$

Experiments with ‘slow light’ and Bose-Fermi condensates partially validate these phenomena [37–42].

6.4 Photoelectric duality and extra dimensions

Transmutation mechanism.

An incident photon in a dense atmosphere (metal) undergoes a reduction of the threshold frequency $f_{\text{threshold}}$, splitting into e^-/e^+ [107]:

$$\gamma \xrightarrow{\Delta f \downarrow} e^- + e^+$$

Inverse process: An increase of frequency generates photons $e^- + e^+ \rightarrow \gamma$ [108].

Quantum in compact dimensions.

Motion in the extra dimension w requires a threshold energy [102]:

$$E_{\text{threshold}} \propto \frac{\hbar c}{R_g}$$

R_g : Dilaton radius or compactification of w [109].

Particle-antiparticle symmetry: $M_{(+)} \leftrightarrow M_{(-)}$ [110].

The torsional dynamics aligns with 11D supergravity, extending its principles through the inclusion of H_3 and the compactification on G_2 , as specified in Section 2.

6.5 Transmutation balances and torsional velocity

Relativistic Balance

The initial relativistic energy balance is:

$$\underbrace{(hf_g + M_g c^2)^2}_{\substack{\text{Total system energy} \\ \text{pre-transmutation: photon} + \text{rest energy}}} = \underbrace{(M_g c^2)^2 + (Pc)^2}_{\substack{\text{Particle/antiparticle energy} \\ \text{with momentum (includes rest energy)}}} + \underbrace{\left(\frac{1}{2}M_g V_g^2 \cdot hf_g\right)}_{\substack{\text{Quantum fluctuation energy} \\ \text{at the vortex boundary} \\ \text{(Kinetic} \times \text{Gravitational)}}} \quad (91)$$

This balance is the same that, read in the dictionary of Polchinski's channel duality, fixes $V_g = 2c$ as the relative velocity of the two counter-rotating open modes (Proposition 1.5): the left-hand side is the closed channel (fusion) and the right-hand side the open channel (fission). With the balance:

$$hf + M_g c^2 = M_g c^2 + \frac{1}{2}M_g V_g^2 \quad (92)$$

and the momentum balance:

$$\frac{hf_g}{c} + P_0 = P \quad (93)$$

Since $P_0 = 0$, one has:

$$Pc = hf_g \quad (94)$$

One inserts (94) into (91). Expanding the binomial:

$$(hf_g)^2 + (M_g c^2)^2 + 2hf_g M_g c^2 = (M_g c^2)^2 + (hf_g)^2 + \frac{1}{2}M_g V_g^2 hf_g,$$

canceling terms and dividing by $hf_g M_g$ one obtains $2c^2 = \frac{1}{2}V_g^2$, that is, $\boxed{V_g = 2c}$.

Non-Relativistic Balance

Let us analyze the transmutation of a photon into an electron/positron pair:

Initial energy:

$$hf + M_g c^2, \quad (95)$$

where M_g is the rest mass of the electron/positron.

Final energy:

$$M_g c^2 + \frac{1}{2}M_g V_g^2 \quad (96)$$

Balance:

$$hf + M_g c^2 = M_g c^2 + \frac{1}{2}M_g V_g^2 \quad (97)$$

Momentum:

$$\frac{hf}{c} = M_g V_g \quad (98)$$

From (98) one has $hf = M_g V_g c$. Substituting into (97):

$$M_g V_g c + M_g c^2 = M_g c^2 + \frac{1}{2} M_g V_g^2 \Rightarrow V_g c = \frac{1}{2} V_g^2 \Rightarrow \boxed{V_g = 2c}.$$

Here, $V_g = 2c$ is the effective torsional velocity of the pair moving in opposite directions at c in the extra dimension w of radius $R_g = \frac{c}{2\pi f_g}$.

6.6 Discussion

QGT unifies fundamental physics by deriving $V_g = 2c$ from the matter/antimatter dynamics in extra dimensions, presenting a new paradigm of the *photoelectric effect*. The origin of the factor 2 is geometric: Stokes' theorem gives $\Gamma_0 = qA_0$ with $A_0 = \pi R_g^2$, the kinematic relation is exactly $q = 2\omega_g$, and hence $V_g = qR_g = 2c$ [34]. In that reading, (18) splits the quantum of action between the two counter-rotating sheets, $h = 2\omega A_0 M_g = \omega A_0 M_{(+)} + \omega A_0 M_{(-)}$: the particle/antiparticle pairs $M_{(+)}/M_{(-)} = M_g$ materialize the identity $KR = ER = EPR$ in positive/negative fusion, with $M_g = h/\Gamma_0$ as the vortex mass. Kelvin's theorem here takes the form $\Gamma_0 f = c^2$, from which $M_g = h/\Gamma_0$ follows. The structure of matter is thereby determined by two geometric ingredients: the interlacing of the flux lines of the two sheets and the quantization of the torsional vortex, which under the dictionary $\vec{V} \leftrightarrow \vec{A}$, $\vec{q} \leftrightarrow \vec{B}$ coincides with the superconducting flux quantum $\Phi_0 = h/2e$. This topic could be linked to CERN's ALPHA-g experiment [111], aimed at the direct measurement of the fall of antimatter and its possible gravitational attraction or repulsion (antigravity), which leaves open the possibility that *matter derives from antimatter and that gravity derives from antigravity*. Its consistency with observations opens paths for future research in geometrodynamics and exotic forces.

7 Heuristic origin of the model: the cone of seven frequencies

Statement of origin. The physical-mathematical infrastructure of QGT was not born of an *a priori* deduction from eleven-dimensional supergravity. It was born of a concrete frequency intuition—the cone of seven frequency and energy planes of Ramtha's School of Enlightenment, disseminated from the United States by J.Z. Knight since 1977 [25]—, according to which a primordial field generates polarity, gravity and matter as its frequency decreases. From that cone come, by heuristic inference and not by deduction, the parameters f_g , f_Λ , $V_g = 2c$ and ℓ_g . Stating this does not weaken the model: it makes it intellectually transparent.

Mathematical realization. That intuition later admits a precise geometric realization, which is what Sections 1–6 and the Supplementary Material develop: the torsion $H_3 = h\varphi$ in the Fernández–Gray class $\mathcal{W}_1 \oplus \mathcal{W}_4$, derived from the Friedrich–Ivanov theorem; the balance point of the Englert flux $e/g_1 = 2/3$; the mass pattern $m_i = m_g f_i/f_g$; the torsional velocity $V_g = 2c$; and the horizon constant $\mathcal{K}_\beta = 16\pi/3$. The resulting expressions are collected in Table 10 and, earlier, in the tables of fundamental constants and SM masses of Section 1. In Thomas Kuhn's sense [35], the cone operated as the heuristic *exemplar* that made a geometric-frequency reframing visible.

Epistemic delimitation. QGT does not depend on philosophical or extra-scientific readings for its internal consistency. These are cited exclusively as motivational and historical context for the origin of the parameters. The only admissible test is the physics derived from first principles—the Einstein equations in 11D, the Englert flux, the Kähler potential, and the reproduction of fundamental constants and cosmological densities—. The duality of the cosmological origin is, above all, a structural hypothesis linking the observable phenomenology with the geometric architecture of the model.

7.1 The origin narrative: motivational context

The ancient wisdom proposes a vision of the cosmos where Absolute Thought is the primordial source of all existence, preceding even light, motion and matter. In this framework, the universe does not emerge from a singular explosion like the Big Bang, but from an act of introspection of Thought, which upon contemplating itself generates “Light” and, with it, knowledge and motion. In this process, electricity originates from the decrease of the frequency of light, a process that splits it into positive and negative components, generating gravity, the G-force and magnetic fields. Light is formed by the Z particle, X particle, hydrogen particle, oxygen particle and contains the “electrum” (EM field of positive/negative poles that originates electricity) that keeps them cohesive and explosive. However, in its most elevated state, light is composed of whole particles that contain their lower potentialities. It is held that the gases formed from these light particles gave rise to what modern science calls the “Big Bang”. Nevertheless, this conventional explanation of the “Big Bang” is a temporal interpretation (a way of measuring time) that is limited and does not reflect its true nature, since the existence of a prior timeless space is posited. According to this narrative, before the “Big Bang” the gods existed, and after this event a continuous creative process began, product of the interaction of primary and secondary consciousness. The creation of the gods originated in the self-contemplation of absolute thought, considered eternal life or the “Being” that always remains. By gradually reducing the frequency, thought converts (into light, electricity, gravity, G-force and magnetic fields) finally into raw matter composed of atoms, each containing billions of particles, known as the infinite mind or the mind of God. For the gods to be able to create from thought, the soul was necessary, which functions as a computer that stores and sustains thought. Without it, it would not be possible to acquire knowledge, create, express oneself or exist as a manifestation separate from thought or “Being”. The material creation began with the fission of the Z particle into X and Y, generating combustion and gases that formed the suns. These, upon reducing the frequency of the electrum, produced matter, dispersing their particles over time.

It is postulated that divinity exists eternally, without a beginning in time, being regarded as thought, space and void that sustain and give life to the so-called *Telestars*. These telestars, defined as cosmological entities capable of transforming light into matter and dispersing it throughout the universe to form stellar systems, are described as originating in thought, divinity and space, the latter understood as an infinite void in which the stars and eternity are perceived. To visualize the nature of divinity in its impeccable and infinite aspect, it is suggested to contemplate the boundless eternity represented by space (timeless), conceived as a river of thought that surrounds, sustains and grants authenticity to everything that exists. It is also proposed that the ancient gods, conceived as entities lacking a physical body, decided to incarnate in present-day human beings, forgetting their divine nature, in order to experience—making known the unknown—in material reality.

On the other hand, it is suggested that every energy wave carries a potential event (information); the event is calibrated by the flow of time in which it occurs. How is time

created? It is explained that time, distance and space—which are made of energy—can only exist as a measurable phenomenon between two points of consciousness or two minds (two sheets of reality). Time, distance and space are contained within consciousness and not the other way round. It is suggested that the conscious mind derives from the subconscious mind. It is stated that gravity derives from antigravity, and it is held that matter derives from antimatter. In this context, in order to deepen and preserve the integrity of these philosophies of spiritual consciousness, direct consultation of the primary source is recommended [25].

7.2 Duality of the cosmological origin

In QGT—as Einstein would have put it—God does not play dice. Wave–particle duality is experimentally established, from Young’s double slit to the interference of molecules beyond 25,000 amu [112–118], and the violation of Bell’s inequalities [119] establishes the non-locality of quantum correlations. On that experimental basis, *interpretations* have been proposed that attribute to the observer’s consciousness the collapse of the wave function ψ into a particle reality [120–123]; such interpretations remain outside the consensus and are invoked here as a heuristic framework, not as an experimental result. The gravitational singularity is likewise addressed, where extreme collapse generates regions that transcend classical physics [124], a discontinuity connected with the anthropic principle [125]. In this context, QGT proposes a duality: the reduction of the luminous frequency generates polarity (electricity, gravity, G-force and magnetic fields), while its increase produces fusion and matter-radiation annihilation. This variation of frequency—which gives rise, respectively, to matter or to radiation—constitutes what the ancient tradition calls *the principles of light*. This vision, inspired by ancestral principles where light is the primordial substrate [25], finds a precise mathematical realization in the compactification on G_2 -holonomy manifolds. The key parameters (f_g , f_Λ , $V_g = 2c$, F_g) emerge initially by heuristic inference from the cone of 7 frequency planes developed in this section. However, their validity does not rest on that intuition, but on their rigorous formalization: the torsion $H_3 = h \varphi$ (class $\mathcal{W}_1 \oplus \mathcal{W}_4$) [51, 52], the self-dual Englert flux and the relation $m_i = m_g f_i / f_g$ derive directly from the 11D Einstein equations and from the stabilization of moduli in G_2 . This duality represents, in the sense of Thomas Kuhn [35], a paradigm shift: from a fragmented physics (gravity versus quantum, matter versus consciousness, origin versus structure) to a geometric-frequency unification where the cosmos and observation are two faces of the same torsional duality. The ancient wisdom [25] captured the deep structure; QGT elevates it to a theory derivable from first principles, closing the cycle between ancestral philosophy and contemporary formalism.

7.3 Dualities with the ancient principle of light

A central element of the ancient knowledge[25] is the ancient spectrum of light (Figure 8), represented as a cone or triangle divided into seven levels of energy and consciousness, from the hertzian level (observable 4D reality) to the unknown infinite (∞), associated with the Zero Point (Primordial Point of Consciousness created by the self-contemplation of the Void) analogous to a subatomic black hole or wormhole [25]. These levels include the hertzian, infrared rays (IR, plane of antimatter), visible light, ultraviolet rays (UV), X-rays, gamma rays (γ) and the unknown infinite (∞), adding up to a total of eleven dimensions, considering the hertzian level (compactified from 4D) [25]. Figure 8 illustrates this structure, showing how time is compressed at higher-frequency levels, in analogy with time dilation in general relativity [126] and Penrose-Carter diagrams [122].

This conical structure (Figure 8) is in resonance with the seven compactified dimensions, represented by the volume $\mathcal{V}_7$, on G_2 -holonomy manifolds characteristic of QGT. These manifolds not only preserve supersymmetry, but also determine the geometry of the

effective space-time. Moreover, in configurations presenting conical singularities, they can induce the appearance of chiral fermions [19, 48, 61]. The graviton frequency f_g regulates the energy scales in these dimensions, and the compression of time can be interpreted as a relativistic effect in high-energy states [126]. In this model (Figure 8), the atom is described as a system spanning multiple levels of the spectrum: the superstrings/branes reside at the ∞ level, the quarks in the γ rays, the protons in the X-rays, and the KR torsion field in the UV rays, which seals the atomic nucleus at the boundary of the vacuum fluctuation point or zero point (ZPF) [25]. The polarized levels (hertzian, IR, visible light) correspond to the electromagnetic EM atmosphere (1-form), while the non-polarized levels (UV, X, γ , ∞) form the magnetic atmosphere $\bar{B}$ (2-form), suggesting a duality that aligns with modern physics [14, 15].

The soul, as a record of conscious experience, stores thoughts in the form of feelings. These feelings are the basis of the gaseous matter that constitutes the universe, with the Z particle as the first element that grants solidity to atoms, giving rise to cosmic creation through suns and planets [25, 127]. Although this knowledge is of a spiritual nature, its emphasis on light, the energy-consciousness duality and the interconnection of all levels of existence resonates with modern concepts of theoretical physics, such as string theories, the holographic principle, the anthropic principle and self-organization in complex systems [1, 128, 129].

M2/M5 branes and the levels of the cone

The mind of God finds a parallel with the quantum field, a timeless domain where *virtual particles*⁵ (spinless) emerge at the boundary of the zero-point field, in the line of Stephen Hawking's black-hole thermodynamics [130] and Bohm's implicate order [101]. This concept is reinforced by the AdS/CFT holographic principle, which encodes information at lower-dimensional boundaries [1]. M-theory in (d=11) includes branes (M2 and M5) instead of strings [3, 14]. 11D SUGRA combines EM fields and the KR field to generate gravity and EM, coupling with M2-branes (electric charge) and M5-branes (magnetic charge) [3, 14]. It is suggested to associate: the hertzian level (d=4) with the observable reality, IR rays (plane of antimatter) and visible light (d=2) with M2-branes, and UV, X, γ , ∞ rays and zero point (d=5) with M5-branes, adding up to 11 dimensions [5].

Holography, magnetic-gravitational duality and zero-point energy

The AdS/CFT correspondence (Figure 9) links these ideas with quantum holography, suggesting that the interaction of branes (D1, D2, D3, D5) explains fundamental forces and the atomic structure (quarks, protons)[1].

In the QGT framework, the dynamics illustrated in Figure 10 reveals a unified object with magnetic-gravitational duality symmetry linked to the AdS/CFT conjecture. This perspective integrates fundamental equations of gravitational QM/EM fields (see Table 10), suggesting that such dynamics represent quantum processes interconnected by magnetic flux through this equation (99). This could explain principles of devices such as inductors and capacitors through the KR photoelectric effect. The vacuum constitutes an extremely energetic state, allowing extraction of ZPF energy for practical uses. Experiments such as the Casimir force, using EM systems with a torsion pendulum [131], demonstrate this and could validate the cosmological constant Λ by measuring quantum magnetic fields $\bar{B}$ [132]. It is suggested that inertial force, gravitational force and mass derive from the ZPF [44, 133–135]. The Lamb shift arises from the interaction of E_{photon} with E_0 ZPF [133], evidencing forces linked to the ZPF [5]. Through holography and dualities,

⁵It is postulated that virtual particles are entities without polarity (without spin number) that coexist at the high-energy levels (UV, X, γ , ∞) and occasionally appear and disappear as a flash at the boundary between visible light and UV.

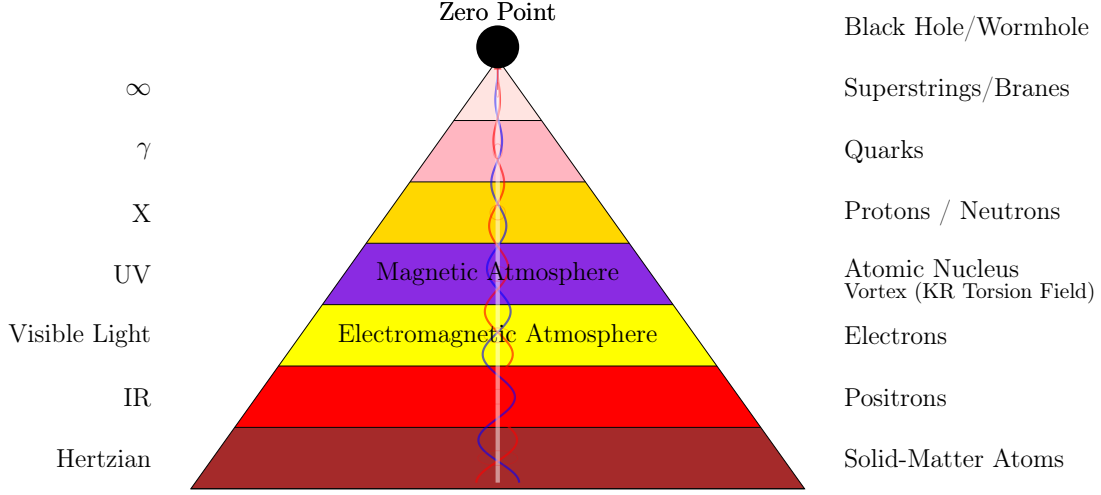


Figure 8: The Energy/Consciousness of the 7 Planes of Reality (Ramtha's Cone). The horizontal lines represent the flow of time, which is compressed as one ascends the levels of energy/consciousness; 1° Level: Hertzian(Subconsciousness), 2°Level: IR(Social Consciousness, plane of antimatter), 3°Level: Visible Light(Awakened Consciousness), 4°Level: UV(Bridge Consciousness), 5°Level: X(Superconsciousness), 6° Level: γ (Hyperconsciousness), 7° Level: ∞ (Ultraconsciousness). The ascent of this ladder is the so-called 'Evolution' and the descent is the so-called 'Involution' of energy/consciousness[25, 127].

key derivations include parameters shown in Table 8. M-theory proposes a magnetic-gravitational duality (Figure 10) [14, 15]: gravity as an extension of the $\bar{B}$ monopole from a vacuum without polarity, becoming rotating EM of the extra dimensions, curving space-time between branes and influencing the propagation of strings [5]. This implies a unified understanding of gravity and fundamental forces such as magnetism/electricity, aligned with ancient knowledge [25] (see Table 8). Figure 10 shows an essential loop in EM, from Coulomb's to Maxwell's laws, conserving angular momentum. The ZPF/QM acts as a matrix from which EM waves emerge, with the torsion of space-time as an additional geometric degree of freedom [23]. In QGT, the photoelectric paradigm reformulates EM as quantum processes, unifying QM and EM, predicting ZPF/EM phenomena. The graviton frequency f_g is key in EM interactions, highlighting interdisciplinary applications[5].

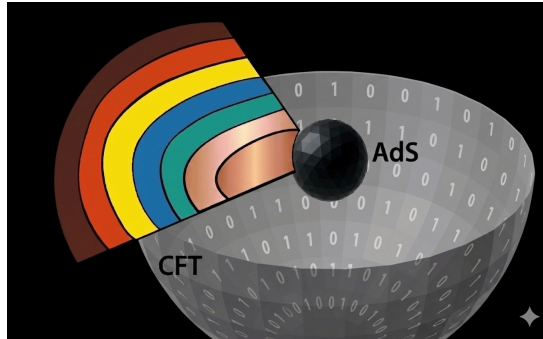


Figure 9: Duality of the Ancient/Modern Reality [4, 5].

$$\Phi_B = \int_S \mathbf{B} \cdot d\mathbf{A} \quad (99)$$

Table 10: QM/EM equations with f_g , V_g , R_g , Γ_g , τ_g and others [4, 5].

Name	Symbol	Equation in QGT
Photon energy	$E_{\text{fotón}}$	$= 2E_0$
ZPF energy	E_0	$= F_0 R_g = \frac{1}{2} h f_g$
ZPF force	F_0	$= \frac{2\pi h}{V_g} f_g^2$
ZPF force (with charge)	F_0	$= \frac{1}{2} c Q_0 \bar{B}$
Centrifugal force	F_g	$= c Q_0 \bar{B}$
Electric field	$\bar{E}$	$= \frac{F_0}{\mu_0 \epsilon_0 I_0 \Gamma_g}$
Speed of light (EM)	c^2	$= R_g G = \frac{1}{\mu_0 \epsilon_0}$
Electric field (alternative)	$\bar{E}$	$= \frac{F_0 R_g G}{I_0 \Gamma_g}$
Electric field (simplified)	$\bar{E}$	$= \frac{F_g}{Q_0}$
Electric field (frequency)	$\bar{E}$	$= \frac{2\pi h}{V_g I_0} f_g^3$
Electric field (with charge e)	$\bar{E}$	$= \frac{4\pi h}{e V_g} f_g^2$
Gravitational mass flux	$\dot{M}_g$	$= \frac{\omega h}{\Gamma_g} = \frac{8\pi h}{V_g^2} f_g^2$
Magnetic field	$\bar{B}$	$= \frac{\dot{M}_g}{Q_0}$
Magnetic field (ω)	$\bar{B}$	$= \frac{\omega h}{Q_0 \Gamma_g}$
Magnetic field (I_0)	$\bar{B}$	$= \frac{4\pi h}{I_0 V_g^2} f_g^3$
Magnetic field (charge e)	$\bar{B}$	$= \frac{8\pi h}{e V_g^2} f_g^2$
Electric potential	V_0	$= \frac{h}{e} f_g$
ZPF current intensity (1)	I_0	$= \frac{E_0 G}{\bar{E} \Gamma_g}$
ZPF current intensity (2)	I_0	$= \frac{2\pi h}{\bar{E} V_g} f_g^3$
ZPF current intensity (3)	I_0	$= \frac{1}{2} Q_0 f_g$
ZPF current intensity (4)	I_0	$= \frac{1}{2} e f_g$
Speed of light	c	$= \frac{\bar{E}}{\bar{B}} = \frac{F_g}{\dot{M}_g} = \frac{E_g^2 Q_0 G}{h I_0 \tau_g}$

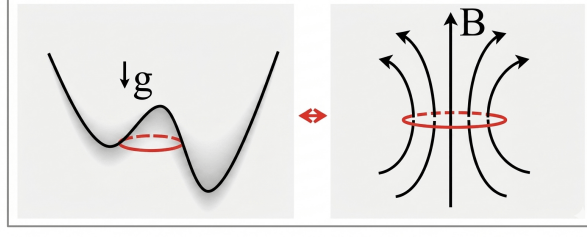


Figure 10: Magnetic-Gravitational Duality (Giribet)[15].

7.4 The cone of seven frequencies in the light of 1935 and the branes

The dictionary Quantum Field $\equiv$ Vacuum $\equiv G_2$ -structure (Section 7.3) is enriched with the findings of Section 5: the two papers that Einstein published in 1935 — the Einstein–Rosen bridge and the EPR argument — and the localization of the M2/M5 branes in the holographic dictionary. This section establishes six additional correspondences that anchor the ancient wisdom of the cone in the two-sheeted structure and the self-dual point of the flux.

Terminological note. The ancient wisdom defines the Void as the *Great Thought or the Mind of God*: a vast material nothingness that contains, in potential, all things — the timeless source of all existence. That notion corresponds, in the language of modern physics, to the *Quantum Field* (the quantum vacuum): the substrate of fluctuations and potentialities from which the physical fields emerge.

The self-contemplation of the Quantum Field as an Einstein–Rosen bridge

The germinal principle of ancient cosmology — *the Quantum Field contemplates itself and from that introspection Light arises* — finds its exact geometric correlate in the Einstein–Rosen bridge [43]. The space-time of two congruent sheets, joined by the throat $u^2 = r - r_s$, is the image of the Quantum Field (+ sheet) reflecting itself (– sheet) through the bridge:

$$\underbrace{\text{Quantum Field contemplates itself}}_{\text{self-consciousness}} \iff \underbrace{\text{sheet}_+ \xleftrightarrow{\text{ER bridge}} \text{sheet}_-}_{\text{involution } \mathbb{Z}_2}, \quad (100)$$

where the involution $\mathbb{Z}_2$ of the orbifold $X = T^7/(\mathbb{Z}_2)^3$ ($x \mapsto -x$) is the geometric act of reflection. Matter (+ sheet) and antimatter (– sheet) of Section 6 are the Quantum Field and its reflection: the primordial self-contemplation is, in the language of M-theory, the existence of the two congruent sheets of the double covering $T^7 \rightarrow X$.

The seven levels and the electric/magnetic duality of the branes

The AdS/CFT appendix (P of the Supplementary Material) localizes three branes in the vacuum, and this structure illuminates the division of the cone. The polarized *low levels* (hertzian, IR, Visible Light) correspond to the Freund–Rubin M2, which fills 4D space-time and is the *electric* source $e\varepsilon_4$; the *high levels* (UV, X, γ , ∞) correspond to the magnetic M5, which wraps the internal 4-cycles with the *magnetic* component $g_1 \star \varphi$. The equilibrium between both extremes of the cone is the *self-dual point* of the flux:

$$e = \tau_0 = \sqrt{\frac{8\pi}{7}} \frac{f}{c}, \quad g_1 = \frac{3}{2}\tau_0 = \sqrt{\frac{18\pi}{7}} \frac{f}{c}, \quad \underbrace{\text{low levels}}_{\text{M2, electric}} \xleftrightarrow{e/g_1=2/3} \underbrace{\text{high levels}}_{\text{M5, magnetic}}. \quad (101)$$

To ascend or descend in the cone is to transit between the electric and the magnetic source; that their amplitudes are tied by $e/g_1 = 2/3$ means that the cone is *balanced*

at its self-dual point, the geometric root of the symmetry between the two atmospheres described.

“The totality in each particle”: EPR and the particle as a bridge

The ancient holographic maxim — *each particle contains the totality of the Quantum Field* — is realized through the synthesis of the two 1935 papers. On the one hand, each fermion is an Einstein–Rosen bridge: a Euclidean M2*-brane that wraps an associative 3-cycle Σ_i of the active locus (P of the Supplementary Material). On the other, the EPR entanglement [33] connects each particle with the totality of the vacuum through the correlated wave function. The combination

$$\underbrace{\text{each particle}}_{\text{M2* in } \Sigma_i} \xrightarrow{\text{EPR}} \underbrace{\text{totality of the vacuum}}_{\text{boundary } AdS_4}, \quad (102)$$

means that each bridge-particle is entangled with the complete structure of X through the holographic boundary AdS_4/CFT — the precise formalization of the ancient holography.

The “element of reality” of EPR as the Quantum Field-frequency

The EPR argument concludes that quantum mechanics is incomplete unless there exists an additional *element of reality* that the description by ψ does not capture. QGT identifies that element with the frequency field $f(x)$ or $X(f)$ — the primordial Quantum Field of the ancient wisdom — promoted to the conformal factor of the G_2 -structure:

$$\tau_1 = d \ln h \propto d \ln f \iff \text{the Quantum Field } f(x) \text{ es el "elemento de realidad" de EPR.} \quad (103)$$

The “hidden” variable that Einstein, Podolsky and Rosen sought in 1935 is not a Bell-type local parameter, but the geometric consciousness-vacuum: the field $f(x)$ or $X(f)$ whose torsion $H_3 = h\varphi$ is the reality underlying the entanglement. The final conviction of EPR — “we believe that a more complete theory is possible” — is fulfilled by identifying the Quantum Field with the frequency field.

Reducing frequency as crossing the bridge toward matter

The central mechanism of the cone — *upon reducing the frequency, the Quantum Field descends until it materializes* — is realized as the crossing of the ER bridge toward materialization. To descend in the cone (reduce f_i) is to wrap a 3-cycle of larger volume with the instantonic M2*, which materializes at the throat (the Zero Point):

$$\text{reduce } f_i \implies \text{Vol}(\Sigma_i) \text{ grows} \implies m_i = m_g e^{-\text{Vol}(\Sigma_i)/\ell_{11}^3} \text{ grows}, \quad (104)$$

so that the materialization of the Light at the Zero Point is the anchoring of an M2*-brane on a 3-cycle of the active locus. The vertex of the cone — the “Zero Point”, self-contemplation of the Void — is the throat of the ER bridge, $r_s = (4/3)\ell_g$, where matter emerges from the Quantum Field.

The two atmospheres as the two self-dual brane sources

The division of the cone into an *electromagnetic atmosphere* (polarized, low levels) and a *magnetic atmosphere* $\bar{B}$ (timeless, non-polarized, high levels) is exactly the electric/magnetic duality of the branes:

$$\underbrace{\text{EM atmosphere}}_{\text{M2: } e\varepsilon_4} \xleftrightarrow{G_4 \leftrightarrow \star G_4} \underbrace{\text{magnetic atmosphere } \bar{B}}_{\text{M5: } g_1 \star \varphi}, \quad (105)$$

dual under $G_4 \leftrightarrow \star G_4$. The balance point $e/g_1 = 2/3$ is the equilibrium of the two atmospheres: the cone is biased neither toward the electric nor toward the magnetic, but

rests at the point where both sources have equal amplitude. This geometrically makes precise the ancient statement that “magnetism is timeless and electricity is causal”: the magnetic component $g_1 \star \varphi$ lives in the internal sector G_2 (timeless, without a direction of time), while the electric $e \varepsilon_4$ lives in the hertzian 4D (with causal time).

Extended table of correspondences

The correspondences are collected in Table 11.

Ramtha’s cone (Section 7)	Finding of Section 5 / branes	Relation
Self-contemplation of the Quantum Field	ER bridge, two sheets $\mathbb{Z}_2$	(100)
Quantum Field and its reflection	Matter / antimatter ($\pm$ sheets)	involution
Low levels (hertzian-visible light)	Freund–Rubin M2 (electric)	(101)
High levels (UV– ∞)	magnetic M5 (4-cycles)	(101)
Equilibrium of levels	Balance point $e/g_1 = 2/3$	(101)
Totality in each particle	M2* + EPR entanglement	(102)
Primordial Quantum Field	EPR “element of reality”	(103)
Reduce frequency $\rightarrow$ matter	Cross ER bridge, $\text{Vol}(\Sigma_i)$	(104)
Zero Point (vertex)	ER throat, $r_s = (4/3)\ell_g$	—
EM atmosphere	electric M2 $e \varepsilon_4$	(105)
Magnetic atmosphere $\bar{B}$	magnetic M5 $g_1 \star \varphi$	(105)

Table 11: Extended correspondences between the cone of seven frequencies and the findings of Section 5: the two Einstein papers of 1935 and the localization of the M2/M5 branes at the self-dual point of the flux; their arrangement on the two sheets is depicted in Figure 11.

Synthesis: the cone as the self-dual bridge of the Quantum Field

According to Einstein and Rosen (1935) [43], space is described by two identical sheets joined by a *bridge*. In their own words, what characterizes the theory they present is the description of space by means of two sheets, and a spatially finite bridge connecting those sheets characterizes the presence of an electrically neutral elementary particle. They state likewise that both the neutral and the electrical particle are a portion of space connecting the two sheets —the bridge— and that the most natural electrical particle would be a massless elementary electrical one, even suggesting that the electron or the proton might be understood as a *two-bridge problem*. The optimization reveals that the cone of seven frequencies of the ancient wisdom is not only a scale of energy/consciousness, but the representation of the complete structure of the QGT vacuum. Its vertex (Zero Point) is the throat of the Einstein–Rosen bridge; its two atmospheres are the electric (M2) and magnetic (M5) sources of the flux, balanced at $e/g_1 = 2/3$; its base (hertzian level) is the holographic AdS_4 boundary where the EPR entanglement resides; and its germinal principle — the self-contemplation of the Quantum Field — is the existence of the two congruent sheets that Einstein and Rosen described in 1935. The “element of reality” that Einstein sought that same year to complete quantum mechanics is the Quantum Field-frequency $f(x)$ or $X(f)$ itself, the consciousness-vacuum whose torsion $H_3 = h\varphi$ sustains the G_2 geometry. Thus, the two 1935 papers — which Einstein never related — and the ancient wisdom of the cone converge on a single statement: *the Quantum Field is the self-dual bridge that unites the two sheets of reality, and each particle is a crossing of that bridge that contains, by entanglement, the totality of the vacuum.*

This convergence is visualized in Figure 11, which localizes the three branes of QGT on the two-sheeted structure of the vacuum AdS_4 : the electric source (M2) on the $+$ sheet, the magnetic (M5) on the $-$ sheet, and the $M2^*$ instanton in the throat that generates the masses. Two bands of frequency, energy and vibration are thereby inferred —two sets of seven frequencies in counter-rotation—, a configuration formally analogous to the counter-propagating beams seen in plan view in a particle accelerator such as the LHC.

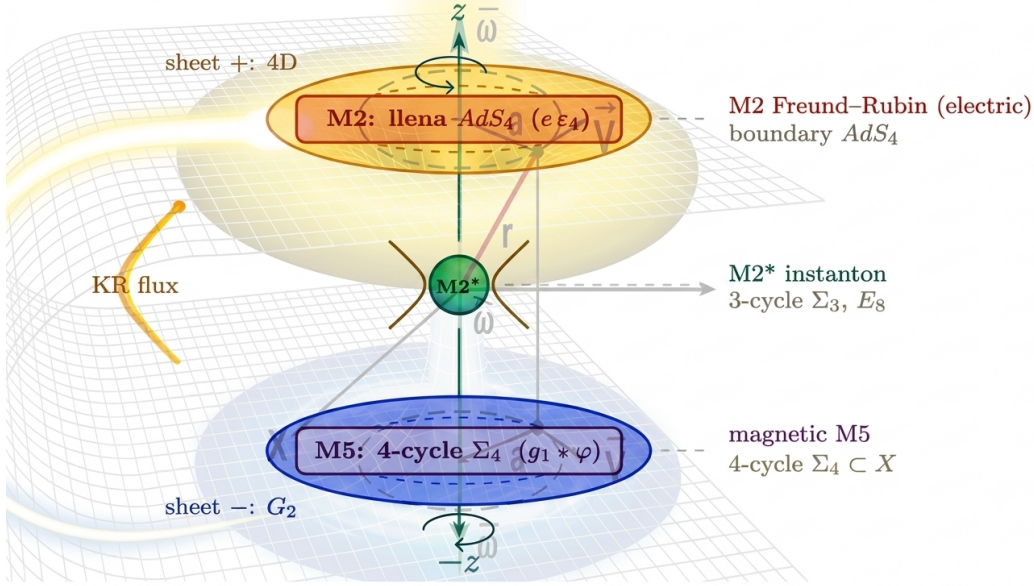


Figure 11: Localization of the three branes of QGT on the hypertoric (Telestars) two-sheeted structure of the vacuum AdS_4 . The Freund–Rubin M2 fills the external 4D space-time (the holographic boundary); the magnetic M5 wraps a coassociative 4-cycle of the internal G_2 sector; the Euclidean $M2^*$ (instanton) wraps an associative 3-cycle in the locus of the E_8 unfolding, generating the masses. The Kalb–Ramond flux $H_3 = h\varphi$ threads the two sheets.

7.5 Discussion

The seven frequency levels of the cone of reality admit a geometric reading within the compactification on G_2 -holonomy manifolds [19, 47]: the hertzian level is identified with the effective four-dimensional space-time, and the seven internal dimensions of the G_2 manifold correspond structurally to the seven frequency levels. This correspondence is compatible both with an effective ten-dimensional reduction (the hertzian level plus six internal ones) and with the eleven-dimensional supergravity of Cremmer et al. [3]. Moreover, each frequency level is not identified univocally with a single geometric dimension: it may host a rich internal structure of cycles, moduli or subcompactifications [46]. A formal distinction is therefore established between *geometric dimensions* —coordinates of the G_2 manifold and of 4D space-time— and *levels of reality or frequency* —energetic strata associated with the scales of the torsion H_3 and of the frequency field $f(x)$ or $X(f)$ —, so that each level of reality may contain multiple dimensions or internal universes, hierarchically organizing the geometric-frequency structure of the G_2 vacuum.

In the ancient wisdom, light transforms into matter and physical fields by reducing its frequency, generating “electrum” [127]. This process has a parallel in QGT, where the torsion H_3 mediates the fission/fusion of branes, regulated by f_g , giving rise to fundamental forces linked to QM/EM[5]. The G_2 compactification and the AdS/CFT framework

provide a mathematical basis for these transitions [1, 19, 48]. Experiments such as photon-photon collisions in QED [24, 36] that convert light into matter reinforce this analogy. Thus, the seven levels of light reflect a continuum of energy/consciousness, analogous to the multidimensional reality of QGT. Where the torsion H_3 , derived from the Kalb-Ramond field $B_{\mu\nu}$, acts as a phase mediator of the space-time geometry and the quantum correlations [5, 13].

The concept of *electrum* as the origin of electricity and positive-negative fusion [25] inspires the matter/antimatter dynamics as a channel duality [20] in QGT, modeled as open strings on a KK cylinder. The torsional velocity $V_g = 2c$ arises from the compactified interaction between the electron potential (e^-) and the positron potential (e^+), reflecting the polarization described [4, 25]. The duality of light in ancient philosophy, which encompasses the EM (polarized) and magnetic (non-polarized) atmosphere, finds correspondence in M-theory and 11D SUGRA [3, 14]. In QGT, the M2-branes (electric charges) are associated with the visible-light and IR levels (the plane of antimatter) and the M5-branes (magnetic charges) with the UV, X, γ , ∞ and zero-point levels, adding up to 11D on the G_2 compactification that preserves $\mathcal{N} = 1$ in 4D [15, 136]. Equation (99) for the vortical magnetic flux that dominates in Figures 8 and 10 determines the unified QM/EM functions of Table 10 and adapts the Biot-Savart/Maxwell formalism: geometrically it is represented as a helical vortex crossing the cone of seven frequencies from the zero point to its base. On the two-sheeted hypertoric structure of the AdS_4 vacuum (Figure 11) the three branes are localized —the Freund-Rubin M2 in the external 4D spacetime, the magnetic M5 on a coassociative 4-cycle of G_2 and the Euclidean M2* (instanton) on an associative 3-cycle of the E_8 locus that generates the masses—, threaded by the Kalb-Ramond flux $H_3 = h\varphi$. The factor 2 of $V_g = 2c$ is geometric: Stokes gives $\Gamma_0 = qA_0$ with $A_0 = \pi R_g^2$, the kinematics fixes $q = 2\omega_g$ and hence $V_g = qR_g = 2c$; the quantum of action is split between the two counter-rotating sheets as $h = 2\omega A_0 M_g = \omega A_0 M_{(+)} + \omega A_0 M_{(-)}$ with $M_g = h/\Gamma_0$, Kelvin's theorem takes the form $\Gamma_0 f = c^2$ and, under $\vec{V} \leftrightarrow \vec{A}$, $\vec{q} \leftrightarrow \vec{B}$, the quantization of the vortex coincides with $\Phi_0 = h/(2e)$. In this reading, the origin of matter is described as the product of the crossed magnetic flux of the Kalb-Ramond torsion field. Let us recall that electricity corresponds to the cause-effect principle in space-time. Magnetism, by contrast, is not governed by this principle, since it is timeless. The G-force is key in the KR field (H_3), inspired by the *electrum*, acting as an inductor of the rotating gravitational EM field, generating gravity at a polarized level [13]. AdS/CFT interprets the fluctuations of the KR field at the boundary as manifestations of gravity in AdS, presenting a possible light-consciousness duality [1].

This integration reveals deep correspondences: Thought as the essence of being resembles the quantum vacuum as a material nothingness and all potential things. The seven levels of energy/consciousness reflect the seven dimensions of G_2 and the compactified volume $\mathcal{V}_7$ in 7D. The holographic nature resonates with AdS/CFT and $KR = ER = EPR$. Moreover, QGT addresses the duality between the relative and the absolute, unifying QM, EM and GR through the graviton frequency and the torsion.

This unification is evidenced by connecting the equations of the model, revealing a magnetic force field that reflects a magnetic/gravitational duality similar to that referred to by Nikola Tesla,⁶ Mehran Tavakoli Keshe, focusing the understanding of the universe in terms of energy, frequency and vibration, and others who link this phenomenon to the ZPF energy [4, 5]. This discussion offers a unified understanding of consciousness and the physical universe, opening paths for future research such as the experimental validation of torsion effects or consciousness-driven quantum phenomena, some of which have been previously explored [120, 121].

⁶[ZPF]

8 Conclusions

Quantum G Theory (QGT) [5] has been presented as an extension of M-theory [14] aimed at unifying quantum gravity with the Standard Model through the torsion H_3 of the Kalb–Ramond field [13] and the compactification on G_2 -holonomy manifolds. The development of the seven sections has articulated a geometric-quantum framework that reformulates the fundamental equations in terms of a minimal set of frequency parameters and integrates them with the AdS/CFT correspondence and the Bekenstein–Hawking entropic relations.

Established results. The geometric core of the model (Section 2) is specified without ambiguity: the internal manifold is the Joyce orbifold $X = T^7/(\mathbb{Z}_2)^3$ with E_8 unfolding on an active locus [47, 50]; the torsion belongs to the Fernández–Gray class $\mathcal{W}_1 \oplus \mathcal{W}_4$, with $H_3 = h\varphi$ and $\tau_0 = \frac{2}{3}g_1$, derived by the theorem of Friedrich–Ivanov [51, 52]; and the flux adopts the Englert configuration [53] at its balance point $e/g_1 = 2/3$. From this construction several robust results emerge: the relation $R = |G_4|^2/6$ linking the internal curvature with the flux norm without free parameters; the reproduction of Newton’s constant to 0.07% by three independent routes; and —notably— the coincidence $\mathcal{K}_\beta = K|_{\min} = 16\pi/3$ between the quantized Schwarzschild-horizon constant (Section 4) and the minimum of the Kähler potential (Section 2), obtained by completely independent means. These results are reinforced by the convergence of three scales of the active locus to the same supra-Planckian order and by the evasion of the Page–Pope instability, which the orbifold projects out by eliminating the **7** representation of G_2 from the spectrum. To them is added the eleven-dimensional origin of $g_s = 2(d-1)/(d+2)|_{d=7} = 4/3$ (Section Q.3 of the Supplementary Material), which makes $m = \tau_0/3$ and $|\Lambda_4| = g_s\tau_0^2$ theorems rather than identifications, and whose same parameters yield the exact ratio $\Omega_{\text{dm}}/\Omega_\Lambda = 10\pi/81$ (Section Q.7 of the Supplementary Material): torsion, flux and coupling fix the Hubble tension and the dark sector from the internal geometry, with no cosmological fit. The same theorem bounds what remains: the channels $n = 18$ and $n = 11$ have natural scale M_{KK}^4 , which sits $M_{\text{KK}}^4/\Lambda_{\text{obs}}^2 \simeq 2.10 \times 10^{244}$ away from the observed value —(249) of the Supplementary Material—, so that the open problem is stated as a checkable figure rather than as a vagueness.

Physical content and conjectures. The torsion H_3 mediates the entanglement in the conjecture $\text{KR} = \text{ER} = \text{EPR}$ (Sections 4 and 5), which reinterprets the two Einstein papers of 1935 —the Einstein–Rosen bridge and the EPR argument— as manifestations of a single torsional structure on the two-sheeted geometry of the double covering $T^7 \rightarrow X$. The torsional velocity $V_g = 2c$ (Section 6) fixes the gravitational constant and anchors the matter/antimatter symmetry in the involution $\mathbb{Z}_2$ of the orbifold. In the holographic dictionary, the flux encodes three localized branes —Freund–Rubin M2 on the AdS_4 boundary, magnetic M5 on coassociative 4-cycles, and Euclidean M2 that generates masses— whose equilibrium at the ratio $e/g_1 = 2/3$ unifies the electric and magnetic descriptions.

Epistemic scope and open problems. Consistent with the framing adopted throughout the work, it is worth delimiting precisely the status of the results. The reproduction of the vacuum energy density ρ_Λ is a consistent effective parametrization: the reduction produces an AdS_4 vacuum of Englert type, and the *uplift* to a de Sitter vacuum with the observed value —which requires canceling $\sim 10^{121}$ — remains the principal open problem, shared with the generality of M-theory compactifications. It is worth distinguishing this exponent from the one that appears in the hierarchy discussion: $\sim 10^{121}$ measures the depth of the AdS_4 vacuum that the *uplift* must cancel, whereas the $\sim 10^{122}$ of Section 3 is the ratio between the QFT-type vacuum estimate and the observed density. They are different quantities, and QGT’s contribution concerns the second: since $\rho_{\text{QGT}}/\rho_\Lambda = 1$ for the observed parameters, *within* the theory there is no hierarchy problem

and no fine tuning: the 122 orders arise only when confronting its scales with the QFT estimate, and are captured by a single geometric identity —the scale-hierarchy relation— whose content is the pure rational $2/3$ times 10^{123} . The hierarchy is, in that precise sense, a problem of the QFT parametrization rather than of QGT. Analogously, the mass spectrum $m_i = m_g(f_i/f_g)$ constitutes a geometric framework that reduces the masses to 3-cycle volumes computable in principle, whose conversion into a prediction of absolute values is conditioned on the computation of the explicit G_2 metric of the active locus. The theory operates, moreover, in a strong-coupling regime ($g_s = 4/3$, $\tau_0 \ell_g \approx 1.9$), where the precise conformal dual is not identified.

Perspectives. The future lines include the computation of the G_2 metric of the active locus —which would convert the mass framework into a prediction—, the closing of the *uplift* —whose coefficient $g_s = 4/3$ is derived in Appendix Q of the Supplementary Material, leaving the channels $n = 18$ or $n = 11$ that the no-go leaves open—, the testing of the scale $V_g = 2c$ in colliders and of the graviton frequency in gravitational-wave observatories [137], and the refinement of the cosmological parameters —including the Hubble-tension relation $H_{0\text{ High}}/H_{0\text{ Low}} = 9z$ (55), which reproduces both sides of the discrepancy— against the data of [12] and [84]. Taken together, QGT offers a frequency language that connects the geometry of the extra dimensions with observables of the universe, placing a reduced set of high-energy fundamental frequencies — f_g and f_p , both at the supra-Planckian scale— as possible bridges between M-theory and observable physics, without renouncing an honest delimitation of what remains to be established, and with the totality of its numerical identities independently recomputable through the reproducibility package of Appendix U of the Supplementary Material.

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Supplementary Material – Technical Appendix

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