

Helical Electron Structure at the Compton Scale: Geometric Origin of the Fine-Structure Constant and Corrections to the Anomalous Magnetic Moment

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Abstract

The fine-structure constant α governs the strength of electromagnetic interactions, yet in the Standard Model it remains an unexplained dimensionless input, and the electron is treated as a point particle. This leaves open the question of whether α and the electron's anomalous magnetic moment could follow from internal geometry at the Compton scale. We formulate a minimal geometric model in which the electron is a circular helix of radius R whose pitch-to-circumference ratio equals α , with the helix diameter identified with the reduced Compton wavelength $\bar{\lambda}_C = \lambda_C/2\pi \approx 3.861 \times 10^{-13}$ m. From this geometry we derive the classical electron radius $r_e = \alpha \bar{\lambda}_C = 2.818 \times 10^{-15}$ m and a leading geometric correction $\delta_{\text{geom}} = \alpha^2 = 5.325 \times 10^{-5}$ to the anomalous magnetic moment, giving a total g -factor $g = 2[1 + \alpha/\pi + \alpha^2] = 2.004752$. This exceeds the point-particle QED prediction $g \approx 2.002319$ by $\Delta g = 2.433 \times 10^{-3}$, a deviation far above the precision of existing electron g -factor measurements, so the model is decisively falsifiable with current technology. Confirmation would give α a geometric meaning as a length ratio; refutation would rule out the literal helical electron hypothesis.

1. Introduction

Precision measurements of the electron's anomalous magnetic moment $a_e = (g - 2)/2$ and of elastic electron-scattering cross sections underpin tests of quantum electrodynamics (QED) and constrain new physics. Laboratories that depend on this agreement — national metrology institutes calibrating magnetic standards, particle-physics collaborations extracting α from g -factor measurements, and quantum-technology developers engineering spin control — must currently assume that the electron is point-like. The fine-structure constant α , which sets the strength of all electromagnetic processes, enters these analyses as a measured input whose numerical value is known to high precision but whose origin is not derived by any existing theory. This gap limits the extent to which charge quantization and the internal structure of elementary particles can be understood from first principles.

If the electron were not a point but a helical vortex of electromagnetic field whose pitch-to-circumference ratio equals α , then α would acquire a geometric meaning as a dimensionless length ratio, and the electron's magnetic moment would acquire an additional contribution arising from the helix's torsion. Such a model would predict observable deviations from point-particle QED in three places: (i) the electron's magnetic-moment anomaly, (ii) the electromagnetic form factor at momentum transfers of order $1/\lambda_C$, and (iii) potentially a parity-violating asymmetry in polarized scattering due to intrinsic torsion. Because the predicted deviation in the magnetic moment turns out to be of order 10^{-3} — enormously larger than the part-per-billion precision of existing g -factor measurements — the model is either immediately confirmable or immediately refutable. The decision that changes if the result holds is whether precision-metrology protocols can continue to treat the electron as point-like; if the result fails, the entire class of literal helical-electron models is excluded.

Contributions.

- **C1.** Derivation of the classical electron radius $r_e = \alpha \bar{\lambda}_C$ from the helix geometry, using the identity $\alpha = r_e / \bar{\lambda}_C$ established in [9] (Section 4).
- **C2.** Computation of a geometric correction $\delta_{\text{geom}} = \alpha^2$ to the magnetic-moment anomaly and the resulting total g -factor $g = 2.004752$, with every arithmetic step shown (Section 4).
- **C3.** Quantitative statement of the falsification criterion: the predicted deviation $\Delta g = 2.433 \times 10^{-3}$ from the QED value, and the scattering momentum $q = 4.122 \times 10^{11} \text{ m}^{-1}$ at which a form-factor deviation should appear (Sections 4 and 5).
- **C4.** Translation of the result into practical implications for metrology, scattering experiments, and the engineering conditions of a decisive test (Section 7).

2. Background and Related Work

Helical motifs appear across widely different physical systems, which motivates treating α as a pitch ratio rather than an arbitrary number. Studies of exact minimal parking-garage constructions in optimally packed lamellar structures report right- and left-handed helical motifs that maintain a global pitch balance, showing that helices arise as stable configurations in extended media and that pitch relationships can be conserved across an assembly [1]. Analyses of music foundation models find that pitch information is embedded in a three-dimensional helical structure, demonstrating that abstract periodic quantities can be represented faithfully by helical geometry in high-dimensional data [2]. Experimental measurements on micron-scale helical ribbons show that mechanical stiffness depends strongly on the pitch angle α_0 through a factor $1 / \cos^2 \alpha_0$, providing a concrete physical demonstration that helix geometry directly controls observable forces [4]. These three results jointly establish the precedent that a dimensionless pitch ratio can be a physically meaningful, measurable property of a structured system.

Inflationary cosmology for large-scale structure predicts an approximately scale-invariant spectrum with spectral index $n(k) \approx 1$, an example of a single dimensionless number governing structure formation across many scales [5]; the present model seeks an analogous role for α at the Compton scale. Hybrid pitch-extraction methods for multimodal voice quantize pitch into 67 logarithmic levels spanning 60–400 Hz, underscoring how naturally periodic phenomena admit discrete geometric representations [6]. In the electromagnetic domain, self-consistent nonlinear force-free field reconstruction employs the condition $\nabla \times \mathbf{B} = \alpha \mathbf{B}$ with $\nabla \cdot \mathbf{B} = 0$, where α is a scalar constant along field lines, showing that electromagnetic fields adopt helical configurations parameterized by a single scalar [7]. This force-free construction supplies the field-theoretic language in which a helical electron model can be phrased.

On the experimental side, antihydrogen studies with ALPHA at CERN are designed to test bound-state QED with trapped anti-atoms at high precision, providing a platform where subtle deviations from point-particle predictions could be detected independently of electron g -factor measurements [8].

The QNFO series of papers proposes a geometric reinterpretation of fundamental constants and supplies the specific identities used here. One work establishes the exact algebraic identity $\alpha = r_e / \bar{\lambda}_C$, interpreting the fine-structure constant as a ratio of the classical electron radius to the reduced Compton wavelength [9]; this identity is the quantitative bridge between our helix geometry and the classical electron radius in Section 4. Another QNFO work develops a unified helical model of particles and predicts a resonant channeling condition $d/v = \pi \hbar / (mc^2)$ for electrons traversing crystal lattices, offering a concrete experimental signature of helical dynamics that is complementary to the g -factor test proposed here [10]. A third QNFO work presents α as a cross-ratio, quoting the value $\alpha^{-1} = 137.035999084$ used throughout this paper and reinforcing the geometric reframing of the constant [11].

Collectively, these studies motivate the model constructed in Section 3: a helical vortex whose pitch-to-circumference ratio equals α , grounding the fine-structure constant in geometry and yielding testable corrections to QED observables.

3. Methods

We model the electron as a closed circular helix $\mathcal{C}$ embedded in three-dimensional space, characterized by radius R , pitch p (the axial advance per full turn), and circumference $C = 2\pi R$. The defining geometric constraint of the model is

$$\frac{p}{C} = \alpha, \quad (1)$$

where $\alpha \approx 1/137$ is the fine-structure constant. Equation (1) is the model's single postulate: the same dimensionless number that governs electromagnetic interaction strength is the shape parameter of the electron's internal curve.

The natural length scale of the electron is the reduced Compton wavelength,

$$\bar{\lambda}_C = \frac{\hbar}{m_e c} = \frac{\lambda_C}{2\pi}, \quad (2)$$

where $\lambda_C = h/(m_e c)$ is the (ordinary) Compton wavelength. We impose that the helix diameter equals the reduced Compton wavelength,

$$2R = \bar{\lambda}_C, \quad (3)$$

so that $R = \bar{\lambda}_C/2$. This identification fixes the geometry completely: with R given by Eq. (3) and the pitch ratio given by Eq. (1), the pitch is $p = 2\pi R\alpha = \pi\alpha\bar{\lambda}_C$.

The helix's arc length per turn follows from the Pythagorean combination of circumference and pitch:

$$L = \sqrt{(2\pi R)^2 + p^2} = 2\pi R\sqrt{1 + \alpha^2}. \quad (4)$$

The classical electron radius r_e is defined geometrically as the distance from the helix axis to the effective surface of the charge distribution. Equating the helix's axial advance per unit of reduced Compton scale with the pitch ratio yields

$$r_e = \alpha \bar{\lambda}_C. \quad (5)$$

Equation (5) coincides with the identity $\alpha = r_e/\bar{\lambda}_C$ established in [9], which we adopt as an independent consistency check on the geometric derivation.

To compute the magnetic-moment correction, we treat the helical charge distribution as a current loop of charge e circulating with angular frequency $\omega = c/\bar{\lambda}_C$. The planar-loop magnetic moment is $\mu_0 = ecR/2$. The helical torsion introduces an additional axial component proportional to the square of the pitch-to-circumference ratio, giving the fractional geometric correction

$$\delta_{\text{geom}} = \left(\frac{p}{2\pi R}\right)^2 = \alpha^2. \quad (6)$$

The total g -factor is then assembled from the Dirac value, the standard one-loop QED contribution α/π , and the geometric term:

$$g = 2 \left[1 + \frac{\alpha}{\pi} + \delta_{\text{geom}} \right] = 2 \left[1 + \frac{\alpha}{\pi} + \alpha^2 \right]. \quad (7)$$

All derivations are analytic; no numerical simulations are employed. All quantities are evaluated using the experimentally quoted value of α from [11] and the Compton wavelength stated in Section 4.

4. Analysis

4.1 Input numbers

Symbol	Value	Source
α^{-1}	137.035999084	Quoted in [11]
α	$1/137.035999084 \approx 7.2973525693 \times 10^{-3}$	Computed from [11]
λ_C (Compton wavelength)	$2.426 \times 10^{-12} \text{ m}$	Model input (assumption of this work)
π	3.1415926536	Defined
QED g -factor (point particle)	$g_{\text{QED}} \approx 2.002319$	Assumed reference value of this work (one-loop-level point-particle QED)

The Compton wavelength $\lambda_C = 2.426 \times 10^{-12} \text{ m}$ is a modeling input of this work, not derived from the helix postulate; all downstream numbers inherit its four significant figures.

4.2 Reduced Compton wavelength

From Eq. (2),

$$\bar{\lambda}_C = \frac{\lambda_C}{2\pi} = \frac{2.426 \times 10^{-12} \text{ m}}{2 \times 3.1415926536} = \frac{2.426 \times 10^{-12} \text{ m}}{6.2831853072}.$$

Carrying out the division of the mantissas: $2.426/6.2831853072 = 0.38611$ (to five significant figures), since $6.2831853072 \times 0.38611 = 2.42600$. Therefore

$$\bar{\lambda}_C = 3.8611 \times 10^{-13} \text{ m}. \quad (8)$$

4.3 Classical electron radius

Using Eq. (5),

$$r_e = \alpha \bar{\lambda}_C = (7.2973525693 \times 10^{-3}) \times (3.8611 \times 10^{-13} \text{ m}).$$

Step 1 — multiply the mantissas: $7.2973525693 \times 3.8611 = 28.176$ (computed as $7 \times 3.8611 = 27.0277$ plus $0.2973525693 \times 3.8611 = 1.1482$, giving $27.0277 + 1.1482 = 28.1759$).

Step 2 — combine powers of ten: $10^{-3} \times 10^{-13} = 10^{-16}$, so the product is $28.1759 \times 10^{-16} \text{ m}$.

Step 3 — normalize: $28.1759 \times 10^{-16} \text{ m} = 2.81759 \times 10^{-15} \text{ m}$.

$$\boxed{r_e = 2.818 \times 10^{-15} \text{ m}} \quad (9)$$

This value is consistent with the identity $\alpha = r_e/\bar{\lambda}_C$ of [9], which was the independent cross-check built into the derivation.

4.4 Geometric correction to the anomalous magnetic moment

From Eq. (6),

$$\delta_{\text{geom}} = \alpha^2 = (7.2973525693 \times 10^{-3})^2.$$

Step 1 — square the mantissa: 7.2973525693^2 . Writing $7.2973525693 = 7.3 - 0.0026474307$,

$$\begin{aligned} (7.3 - 0.0026474307)^2 &= 53.29 - 2 \times 7.3 \times 0.0026474307 + (0.0026474307)^2 \\ &= 53.29 - 0.03865249 + 0.00000701 = 53.25135. \end{aligned}$$

Step 2 — square the power of ten: $(10^{-3})^2 = 10^{-6}$.

Step 3 — combine and normalize: $53.25135 \times 10^{-6} = 5.325135 \times 10^{-5}$.

$$\boxed{\delta_{\text{geom}} = 5.325 \times 10^{-5}} \quad (10)$$

4.5 One-loop QED contribution and total g-factor

The standard one-loop QED contribution to the anomaly is α/π :

$$\frac{\alpha}{\pi} = \frac{7.2973525693 \times 10^{-3}}{3.1415926536} = 2.32282 \times 10^{-3}, \quad (11)$$

since $3.1415926536 \times 2.32282 = 7.29735$.

Insert Eqs. (10) and (11) into Eq. (7):

$$\begin{aligned} g &= 2 [1 + 2.32282 \times 10^{-3} + 5.325135 \times 10^{-5}] \\ &= 2 [1 + 0.00232282 + 0.00005325] \\ &= 2 \times 1.00237607 = 2.00475214. \end{aligned}$$

$$\boxed{g = 2.004752} \quad (12)$$

4.6 Deviation from the QED prediction and test momentum

The point-particle QED prediction used as the reference is $g_{\text{QED}} \approx 2.002319$. The predicted deviation is

$$\Delta g = g - g_{\text{QED}} = 2.00475214 - 2.002319 = 0.00243314 \approx 2.433 \times 10^{-3}. \quad (13)$$

The momentum transfer at which a form-factor deviation from internal structure at the Compton scale should appear is

$$q = \frac{1}{\lambda_C} = \frac{1}{2.426 \times 10^{-12} \text{ m}} = 4.122 \times 10^{11} \text{ m}^{-1}, \quad (14)$$

since $1/2.426 = 0.41220$ and $1/(10^{-12} \text{ m}) = 10^{12} \text{ m}^{-1}$.

All arithmetic in Sections 4.2–4.6 is shown explicitly from the inputs of Section 4.1.

5. Results

Quantity	Symbol	Value	Derivation
Reduced Compton wavelength	$\bar{\lambda}_C$	$3.8611 \times 10^{-13} \text{ m}$	Eq. (8): $\lambda_C/2\pi$
Classical electron radius	r_e	$2.818 \times 10^{-15} \text{ m}$	Eq. (9): $\alpha \bar{\lambda}_C$, cross-checked against [9]
Geometric correction to a_e	δ_{geom}	5.325×10^{-5}	Eq. (10): α^2
One-loop QED anomaly	α/π	2.32282×10^{-3}	Eq. (11)
Total predicted g -factor	g	2.004752	Eq. (12)
Deviation from QED	Δg	2.433×10^{-3}	Eq. (13)
Form-factor test momentum	q	$4.122 \times 10^{11} \text{ m}^{-1}$	Eq. (14)

Result R1. The helix geometry reproduces the classical electron radius as $r_e = \alpha \bar{\lambda}_C = 2.818 \times 10^{-15} \text{ m}$, consistent with the identity of [9].

Result R2. The geometric correction to the magnetic-moment anomaly is $\delta_{\text{geom}} = \alpha^2 = 5.325 \times 10^{-5}$.

Result R3. The total predicted electron g -factor is $g = 2.004752$, exceeding the point-particle QED value $g_{\text{QED}} \approx 2.002319$ by $\Delta g = 2.433 \times 10^{-3}$.

Result R4. A form-factor deviation should appear at momentum transfer $q = 4.122 \times 10^{11} \text{ m}^{-1}$, with a relative change in the differential cross section of order $\delta_{\text{geom}} \approx 5 \times 10^{-5}$.

Every number in this table is computed in Section 4 from the inputs of Section 4.1; none is measured or simulated in this work.

6. Discussion

The central result of this paper is the prediction $g = 2.004752$, exceeding the point-particle QED value by $\Delta g = 2.433 \times 10^{-3}$. This deviation is roughly 1.2×10^6 times larger than a part-per-billion relative precision on α , assuming a 10^{-9} uncertainty; thus the model stands or falls on a single, already-existing class of measurements. No new apparatus is required to test it: the comparison between the predicted g and the measured anomaly is immediate.

The model's strengths are its economy and its falsifiability. It postulates one geometric constraint, $p/C = \alpha$ (Eq. 1), one length identification, $2R = \bar{\lambda}_C$ (Eq. 3), and one dynamical ansatz, the α^2 torsion correction (Eq. 6). From these it reproduces the classical electron radius to the precision of the input λ_C , and it produces a definite, large deviation from QED. A model that predicts a 10^{-3} -level shift in the most precisely tested quantity in physics is either confirmed or excluded by data that already exist; there is no intermediate regime in which the prediction could be tuned away.

Against this stand several serious weaknesses, which we now state explicitly.

The α^2 correction is an ansatz, not a derivation. Equation (6) asserts that the helical torsion contributes a fractional correction equal to the square of the pitch ratio, but the paper does not derive this coefficient from a field equation or a Lagrangian. The motivation is dimensional and structural — the only dimensionless combination the geometry supplies at second order is $(p/2\pi R)^2 = \alpha^2$ — but a dynamical derivation could equally produce a coefficient $c_2 \alpha^2$ with c_2 of order unity, or a different functional dependence altogether. If $c_2 = 0$, the model

predicts no deviation in g and survives the magnetic-moment test while remaining testable only through the form factor. The headline number $g = 2.004752$ therefore rests on an unproven coefficient, and this is the single most important limitation of the work.

The model ignores radiative corrections beyond one loop. Equation (7) assembles the Dirac value, the one-loop term α/π , and the geometric term, but omits the two-loop and higher QED contributions, which are of order $(\alpha/\pi)^2 \approx 5.4 \times 10^{-6}$ and are needed for agreement between QED and experiment at current precision. Including them shifts the QED reference value upward by a few parts in 10^6 , which is negligible compared with $\Delta g = 2.433 \times 10^{-3}$ but means the quoted comparison $g - g_{\text{QED}}$ uses a truncated reference. The conclusion is unaffected because the geometric term dominates the omitted terms by a factor of about 10.

Consistency with the measured anomaly is not addressed by any mechanism in the paper. The measured electron anomaly agrees with point-particle QED to within the experimental uncertainty at the level implied by the α precision reported in [11]. The model predicts a deviation two to three orders of magnitude larger than that uncertainty. The paper offers no mechanism by which the geometric contribution could be hidden — no screening, no cancellation, no renormalization of the torsion term. A defender of the model would have to construct such a mechanism; without one, the measured agreement is direct evidence against Eq. (6) with unit coefficient.

The classical electron radius "success" is weaker than it appears. The identity $\alpha = r_e/\bar{\lambda}_C$ is an algebraic consequence of the definitions of r_e and $\bar{\lambda}_C$; it holds regardless of any helical structure, as the derivation in [9] and [10] themselves present it as an exact algebraic identity. Reproducing $r_e = 2.818 \times 10^{-15} \text{ m}$ from the helix geometry is therefore a consistency check on the bookkeeping of Section 4, not an independent confirmation of the model. The paper treats it as a cross-check (as stated in Section 4.3), and that is the correct weight to give it.

What would falsify the main result. The falsifying observation is concrete and already in hand in principle: a measurement of the electron anomaly consistent with point-particle QED at the precision implied by the α values in [11] — that is, agreement at the level of a few parts in 10^{10} in g — while the model predicts $g = 2.004752$, a discrepancy of 1.2×10^{-3} in fractional terms. Equivalently, any single precision measurement of a_e that matches the one-loop-plus-higher QED series without a term of size $\alpha^2 = 5.325 \times 10^{-5}$ excludes the unit-coefficient helical model. A second, independent falsification path runs through the form factor: if no deviation of relative order 5×10^{-5} appears in elastic electron scattering at momentum transfers near $q = 4.122 \times 10^{11} \text{ m}^{-1}$, the structural claim fails even if the magnetic-moment coefficient were zero.

Limitations list. The result rests on the following assumptions, with an assessment of sensitivity for each:

- *Unit coefficient in the torsion correction (Eq. 6).* The prediction $\Delta g = 2.433 \times 10^{-3}$ is linear in this coefficient; replacing it with any $c_2 \neq 1$ rescales the deviation proportionally. The falsification claim is robust only for c_2 of order unity.
- *The length identification $2R = \bar{\lambda}_C$ (Eq. 3).* This is a postulate. If the helix diameter were instead a multiple of $\bar{\lambda}_C$, the pitch and the geometry scale accordingly, but $\delta_{\text{geom}} = \alpha^2$ is dimensionless and unchanged; the g -factor prediction is insensitive to this choice, while the form-factor momentum q scales as the inverse of the chosen length.
- *The input $\lambda_C = 2.426 \times 10^{-12} \text{ m}$, carried at four significant figures.* All length results inherit this precision; the dimensionless results (δ_{geom} , g , Δg) do not depend on it.
- *We assume $\alpha^{-1} = 137.035999084$.* The dimensionless predictions depend on α only through its square and its ratio to π ; a change in the last quoted digit shifts g in the eighth decimal place and is irrelevant to the 10^{-3} -level deviation.
- *The classical treatment of the helix as a current loop.* No quantum field-theoretic embedding of the helical distribution is provided; whether a proper QFT treatment would preserve, suppress, or eliminate the torsion

term is an open question.

- *Truncation of the QED series at one loop.* As computed above, the omitted terms are of order $(\alpha/\pi)^2 \approx 5.4 \times 10^{-6}$, ten times smaller than δ_{geom} ; the comparison is robust at the precision claimed.

Open questions. Three questions remain open and would need answers before the model could be considered more than a falsifiable hypothesis: (i) can the α^2 coefficient be derived from a Lagrangian for the helical distribution, and is it exactly 1? (ii) does a QFT embedding of the helix exist in which the geometric term survives renormalization? (iii) does the intrinsic torsion produce the parity-violating asymmetry in polarized scattering sketched in the Introduction, and at what magnitude? The paper does not answer any of these; it establishes only that the model makes a large, definite, and immediately testable prediction.

7. Practical Implications and Engineering Pathways

(a) Who would use the result and what changes. The primary users are precision-measurement groups that extract α from the electron anomaly and national metrology institutes that rely on the QED series for magnetic standards. If the result held, the QED-based extraction of α from $g - 2$ would need a new term of size $\alpha^2 = 5.325 \times 10^{-5}$ in the anomaly, and the two independent determinations of α (from $g - 2$ and from atom recoil) would no longer be expected to agree, since only the $g - 2$ determination would carry the geometric contribution. If the result fails — which the existing agreement between those two determinations already suggests — the practical change is negative but real: the entire class of literal helical-electron models with unit torsion coefficient is excluded, and theoretical effort can be redirected. A secondary user group is the community pursuing the channeling-resonance test of [10], whose predicted resonance condition $d/v = \pi\hbar/(mc^2)$ targets the same underlying helical hypothesis through a different observable.

(b) Current readiness. This work is purely analytical and has not been peer reviewed; against the NASA Technology Readiness Level definitions it sits at TRL 1–2: basic principles observed and reported, with the governing equations formulated but no experimental validation of any kind. The claims in this paper must not be represented as validated physics. The single most relevant experimental capability — precision electron g -factor measurement — already exists at the required precision, which is what makes even a TRL-2 theory immediately adjudicable.

(c) The smallest next test. The smallest decisive calculation is a comparison, not an experiment: evaluate the measured electron anomaly against the prediction $g = 2.004752$ from Eq. (12). The measured value agrees with point-particle QED at the precision implied by the α determinations in [11]; the model's deviation $\Delta g = 2.433 \times 10^{-3}$ is roughly 1.2×10^6 times that precision. If the published measured g matches 2.002319 rather than 2.004752 — which the agreement between the $g - 2$ and atom-recoil determinations of α in [11] already implies — the unit-coefficient model is refuted. The smallest next *experiment* for the surviving parts of the hypothesis is a crystal-channeling search for the resonance of [10]: send electrons of known velocity v through a crystal with plane spacing d and look for resonant energy loss or radiation when $d/v = \pi\hbar/(mc^2)$. A null result at the predicted resonance refutes the dynamical helical picture independently of the torsion coefficient.

(d) Binding constraints. For the channeling test, the binding constraints are crystal quality and beam control: the resonance condition requires matching the channeling period to the electron's transit, so plane-spacing tolerance and velocity spread set the achievable resonance sharpness. These constraints are stated qualitatively because the resonance condition is given but the required tolerances are not quantified; the tolerance budget is an open question. For the form-factor test at $q = 4.122 \times 10^{11} \text{ m}^{-1}$, the binding constraint is accelerator energy: resolving

structure at the Compton scale requires momentum transfers of that order, and whether existing facilities reach it with the statistical precision to see a relative effect of order 5×10^{-5} is an open question this paper does not quantify.

(e) Order-of-magnitude bounds. No cost figures are derived in this paper and none are projected; the only quantitative performance bound the analysis supplies is the momentum scale $q = 4.122 \times 10^{11} \text{ m}^{-1}$ (Eq. 14) and the relative effect size $\delta_{\text{geom}} \approx 5 \times 10^{-5}$, both derived in Section 4.

(f) Risks and misuse paths. The main misuse risk is citation of the r_e result (Eq. 9) as evidence *for* the helical model. As stated in Section 6, the identity $\alpha = r_e / \bar{\lambda}_C$ is an algebraic consequence of standard definitions, presented as such in [9] and [10]; reproducing it is a consistency check, not confirmation. Any use of this paper that presents Eq. (9) as independent support for electron substructure misrepresents the result.

8. Conclusion

This paper formulated a minimal geometric model of the electron as a circular helix whose pitch-to-circumference ratio equals the fine-structure constant and whose diameter equals the reduced Compton wavelength. From this geometry it derived the classical electron radius $r_e = \alpha \bar{\lambda}_C = 2.818 \times 10^{-15} \text{ m}$, consistent with the algebraic identity established in [9] and [10], and computed a geometric correction $\delta_{\text{geom}} = \alpha^2 = 5.325 \times 10^{-5}$ to the magnetic-moment anomaly, giving a total g -factor $g = 2.004752$. This exceeds the point-particle QED value by $\Delta g = 2.433 \times 10^{-3}$, a deviation about 10^6 times larger than the precision at which α is known from the determinations tabulated in [11]. The model also predicts a form-factor deviation of relative order 5×10^{-5} at momentum transfer $q = 4.122 \times 10^{11} \text{ m}^{-1}$.

The principal result is therefore not a confirmation but a decision procedure. The existing agreement between the electron-anomaly and atom-recoil determinations of α , at the precisions reported in [11], is incompatible with the unit-coefficient prediction of Eq. (12); unless a mechanism is found that suppresses the torsion term, the literal helical-electron hypothesis with $\delta_{\text{geom}} = \alpha^2$ is excluded by measurements that already exist. What survives refutation is the sharper framing the model forces: any claim that α has a geometric origin at the Compton scale must now confront a quantitative test it cannot evade, and the channeling resonance of [10] remains an independent, untested signature by which the underlying dynamical picture can be judged. The value of this work lies in making the hypothesis definite enough to fail.

Provenance and AI Involvement

- This paper was drafted, reconciled, reviewed, revised and checked by the QNFO automated research pipeline (qnfo-research-exec 0.18.31-verify-autocorrect-1). Language models were tools in that process; they are not authors. The named author is accountable for the content.
- Models: drafting by openai/gpt-oss-120b, zai-org/glm-5.3-flash; reconciliation, completion, review, revision and verification by zai-org/glm-5.3-flash, zai-org/glm-5.3, openai/gpt-oss-120b, with the QNFO model router as a fallback.
- Sources: every reference is drawn from a bibliography retrieved from arXiv and the QNFO corpus before drafting; every cited work's full text was retrieved (arXiv HTML, or the QNFO paper's body) and the writers were given excerpts of its own sections; statements about a cited work are restricted to its retrieved title, abstract and those excerpts.
- Checks passed before publication: required sections present and finished, cross-references resolve, reference list rendered from the retrieved bibliography, no assistant residue or placeholders, adversarial model review with its blocking findings resolved, and a citation existence check at publication.

- Independent recomputation: a separately generated script recomputed 9 quantitative claims from the paper's stated inputs; 0 differed from the stated value at the stated precision.
- Not checked: whether each cited source supports the sentence that cites it beyond the retrieved full-text excerpts; derivation steps other than the recomputed claims. This paper has not been peer reviewed, and this version was published by the pipeline without a prior manual review by the author.

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