The Eight-Layer Donut Model: A Geometric Derivation of the Electron Mass

Parameter-Free Predictions and Experimental Tests

S. M. H. Emamifar ORCHARD: 0009-0007-6257-0163
DR.Zahra Derakhshani
IRCBHC Collaboration

March 2026

Abstract

This paper presents a complete, parameter-free geometric model of the electron. Starting from closed-path quantization and a binary ladder of scales anchored at the Planck length, we derive an eight-layer mirror-symmetric structure. The layer capacities are powers of $\Xi = 2/\alpha$, leading to a total wave count $S_{\text{total}} = 2(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1)$. The excess over half the Compton frequency, about 3%, gives an inertial margin of 7.8 keV, which predicts a resonance in electron–photon scattering. The model also explains the origin of electric charge, the Pauli exclusion principle, and the hierarchy of scales generated by the fine-structure constant. All predictions are falsifiable and within reach of current experimental technology.

Contents

1 Introduction: The Wounded Serpent Intuition **4**
1.1 The Wounded Serpent: An Intuitive Starting Point 4
1.2 Why a Single-Scale Confinement Fails 4

2 Introduction: The Wounded Serpent Intuition **5**
2.1 The Wounded Serpent: An Intuitive Starting Point 6
2.2 Why a Single-Scale Confinement Fails 6
2.3 Scope of the Model 7

3 Foundational Principles **7**
3.1 Closed-Path Quantization 7
3.2 Frame Ladder and the Planck Anchor 8
3.3 Capacity Norm and the Origin of Lorentz Factors 8
3.4 Wave-Count Conservation in Gravitational Fields 9

4 The Eight-Layer Donut Structure **9**
4.1 Layer Capacities as Powers of Ξ 10
4.2 Why Eight Layers? 10
4.3 Total Wave Count and the 3% Inertial Margin 11
4.4 The 7.8 keV Inertial Margin 12

5 Dynamics and Symmetry **12**
5.1 Phase Locking and the Critical Angle 12
5.2 Phase-Decoupling Radius 12
5.3 Phase Visibility Boundary and Wave-Particle Duality 13
5.4 Asymmetry-Driven Linear Motion 13

6 The Fine-Structure Constant as a Geometric Kernel **13**

7 Experimental Predictions **14**
7.1 Resonant X-Ray Scattering at 7.8 keV 14
7.2 Gravitational Redshift Anomaly 14

8 Conclusion and Outlook **15**

9 Conclusion and Outlook **16**
9.1 Limitations and Open Questions 17
9.2 Outlook 18

A List of Supporting Blocks **19**

B Introduction: The Wounded Serpent Intuition **20**
B.1 The Wounded Serpent: An Intuitive Starting Point 20
B.2 Why a Single-Scale Confinement Fails 21
B.3 Scope of the Model 21

C Foundational Principles **21**
C.1 Closed-Path Quantization 22
C.2 Frame Ladder and the Planck Anchor 22
C.3 Capacity Norm and the Origin of Lorentz Factors 23
C.4 Wave-Count Conservation in Gravitational Fields 23

D The Eight-Layer Donut Structure **24**
D.1 Layer Capacities as Powers of Ξ 24
D.2 Why Eight Layers? 25
D.3 Total Wave Count and the 3% Inertial Margin 25
D.4 The 7.8 keV Inertial Margin 26

E Dynamics and Symmetry **26**
E.1 Phase Locking and the Critical Angle 26
E.2 Phase-Decoupling Radius 27
E.3 Phase Visibility Boundary and Wave-Particle Duality 27
E.4 Asymmetry-Driven Linear Motion 27

F The Fine-Structure Constant as a Geometric Kernel **28**

G Experimental Predictions **28**
G.1 Resonant X-Ray Scattering at 7.8 keV 28
G.2 Gravitational Redshift Anomaly 29

H Conclusion and Outlook **29**
H.1 Limitations and Open Questions 30
H.2 Outlook 31

A List of Supporting Blocks **31**

1 Introduction: The Wounded Serpent Intuition

The origin of rest mass remains one of the deepest questions in physics. While the Standard Model introduces mass through the Higgs mechanism, it does not explain why the electron has exactly $0.511\,\mathrm{MeV}/c^2$. The eight-layer donut model offers a different perspective: mass emerges from the confinement of a wave on a closed path, together with a hierarchical layered structure whose scales are set by the fine-structure constant α and the Planck length. The model is entirely parameter-free; once α, $\hbar$, c, and the Planck scale are fixed, the electron mass is uniquely determined.

1.1 The Wounded Serpent: An Intuitive Starting Point

The model originates from a simple geometric intuition, which we call the "Wounded Serpent". Imagine two high-energy photons (each with energy $0.511\,\mathrm{MeV}$) approaching each other in a nearly head-on collision, but with a slight transverse offset. In the overlap region, the peaks of one photon almost coincide with the troughs of the other, leading to nearly complete cancellation. However, because the collision is not perfectly centered, a small residual field remains. This residual, which is about $1/274$ of the original amplitude, creates an asymmetry – a "wound" – that forces part of the electromagnetic field to curve and close upon itself. Thus, instead of continuing as free radiation, the field forms a closed loop. This closed loop is the seed of the electron's rest mass.

This intuition naturally leads to a two-scale structure: a highly compressed inner region (the "head" of the serpent) and a larger, circulating outer region (the "tail"). The inner region will eventually become the core of the electron, while the outer region will become its wave-like envelope.

1.2 Why a Single-Scale Confinement Fails

One might naïvely think that a single closed loop of light could represent the electron. However, as shown in Article #106 (block ART-106), this idea fails quantitatively. If the entire energy of a $0.511\,\mathrm{MeV}$ photon were confined to a region much smaller than its wavelength, the required phase-wrapping factor would be enormous (on the order of 10^5). Moreover, if electric charge were also confined to such a tiny core, its electromagnetic self-energy would be hundreds of MeV, far exceeding the electron's total energy. Therefore, the electron cannot be a single-scale object; it must have at least two distinct scales: a compact core that carries most of the mass, and an extended region that supports the charge. This necessity is the foundational motivation for the eight-layer donut model.

"'latex

[12pt]article amsmath, amssymb, graphicx hyperref [utf8]inputenc geometry a4paper, margin=1in

The Eight-Layer Donut Model: A Geometric Derivation of the Electron Mass

Parameter-Free Predictions and Experimental Tests S. M. H. Emamifar, Z. Derakhshani
IRCBHC Collaboration March 2026

Abstract

We present a complete, parameter-free geometric model of the electron. Starting from closed-path quantization and a binary ladder of scales anchored at the Planck length, we derive an eight-layer mirror-symmetric structure. The layer capacities are powers of $\Xi = 2/\alpha$, leading to a total wave count $S_{\text{total}} = 2(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1)$. The excess over half the Compton frequency, about 3%, gives an inertial margin of 7.8 keV, which predicts a resonance in electron–photon scattering. The model also explains the origin of electric charge, the Pauli exclusion principle, and the hierarchy of scales generated by the fine-structure constant. All predictions are falsifiable and within reach of current experimental technology.

Contents

2 Introduction: The Wounded Serpent Intuition

The origin of rest mass remains one of the deepest questions in physics. While the Standard Model introduces mass through the Higgs mechanism, it does not explain why the electron has exactly $0.511\,\mathrm{MeV}/c^2$. The eight-layer donut model offers a different perspective: mass emerges from the confinement of a wave on a closed path, together with a hierarchical layered structure whose scales are set by the fine-structure constant α and the Planck length. The model is entirely parameter-free; once α, $\hbar$, c, and the Planck scale are fixed, the electron mass is uniquely determined.

2.1 The Wounded Serpent: An Intuitive Starting Point

The model originates from a simple geometric intuition, which we call the "Wounded Serpent". Imagine two high-energy photons (each with energy 0.511 MeV) approaching each other in a nearly head-on collision, but with a slight transverse offset. In the overlap region, the peaks of one photon almost coincide with the troughs of the other, leading to nearly complete cancellation. However, because the collision is not perfectly centered, a small residual field remains. This residual, which is about 1/274 of the original amplitude, creates an asymmetry – a "wound" – that forces part of the electromagnetic field to curve and close upon itself. Thus, instead of continuing as free radiation, the field forms a closed loop. This closed loop is the seed of the electron's rest mass.

This intuition naturally leads to a two-scale structure: a highly compressed inner region (the "head" of the serpent) and a larger, circulating outer region (the "tail"). The inner region will eventually become the core of the electron, while the outer region will become its wave-like envelope. The number 274 that appears here is not arbitrary; it will later be identified with $2/\alpha$, where α is the fine-structure constant.

2.2 Why a Single-Scale Confinement Fails

One might naïvely think that a single closed loop of light could represent the electron. However, as shown in Article #106 (block ART-106), this idea fails quantitatively. If the entire energy of a 0.511 MeV photon were confined to a region much smaller than its wavelength, the required phase-wrapping factor would be enormous (on the order of 10^5). Moreover, if electric charge were also confined to such a tiny core, its electromagnetic self-energy would be hundreds of MeV, far exceeding the electron's total energy. Therefore, the electron cannot be a single-scale object; it must have at least two distinct scales: a compact core that carries most of the mass, and an extended region that supports the charge. This necessity is the foundational motivation for the eight-layer donut model.

2.3 Scope of the Model

It is important to emphasize that this model is developed strictly for the electron. The eight-layer structure is derived specifically from the electron's properties and does not automatically apply to other particles. In the accompanying block package, there are informal discussions exploring whether similar layered structures might exist for muons, taus, or other particles. These are not part of the core model—they are speculative remarks included to stimulate discussion and should be treated as such. The core model stands independently and makes no claims about any particle other than the electron.

3 Foundational Principles

Before constructing the eight-layer structure, we must establish the foundational principles on which the model rests. These principles are purely operational and rely on counting and geometry rather than on imported physical assumptions.

3.1 Closed-Path Quantization

Consider a relativistic wave confined to a closed path of length L. For the wavefunction to be single-valued, the total phase accumulated over one full traversal must be an integer multiple of 2π:

$$kL = 2\pi n, \quad n \in \mathbb{Z}. \tag{1}$$

Here $k = 2\pi/\lambda$ is the wave number. For the lowest mode $n = 1$, we have $L = \lambda$. The energy of such a mode is $E = \hbar ck = \hbar c/R$ where $L = 2\pi R$. Identifying this with the rest energy mc^2 yields the fundamental mass-radius relation:

$$m = \frac{\hbar}{Rc}. \tag{2}$$

Thus mass is not an intrinsic property but a consequence of confinement on a closed path. This relation will be used repeatedly in the following sections.

3.2 Frame Ladder and the Planck Anchor

We introduce a discrete ladder of frames (ranks) indexed by a continuous rank r, with $r = 0$ corresponding to the Planck floor. Each step up the ladder doubles both the length unit and the time unit:

$$L(r) = l_P\, 2^r, \qquad T(r) = t_P\, 2^r, \tag{3}$$

where $l_P = \sqrt{\hbar G/c^3} \approx 1.616 \times 10^{-35}\,\mathrm{m}$ and $t_P = l_P/c \approx 5.391 \times 10^{-44}\,\mathrm{s}$ are the Planck length and time. An immediate consequence is that the ratio $L(r)/T(r) = l_P/t_P = c$ is invariant across all frames. This provides an operational origin for the constancy of the speed of light without invoking spacetime geometry.

Our physical frame is identified by matching the step length to the reduced Compton wavelength of the electron:

$$L_{\text{step}} \equiv \frac{\lambda_C}{2\pi} = \frac{\hbar}{m_e c} \approx 3.8616 \times 10^{-13}\,\mathrm{m}. \tag{4}$$

One "tick" in our frame is the time required for light to travel one step length:

$$T_{\text{tick}} = \frac{L_{\text{step}}}{c} \approx 8.0933 \times 10^{-21}\,\mathrm{s}. \tag{5}$$

The rank of our frame relative to the Planck floor is then

$$r_{\text{current}} = \log_2\left(\frac{L_{\text{step}}}{l_P}\right) = \log_2\left(\frac{T_{\text{tick}}}{t_P}\right) \approx 76.99. \tag{6}$$

This number will appear later in the calibration of layer capacities.

3.3 Capacity Norm and the Origin of Lorentz Factors

Each tick carries a fixed total "capacity" C_{total} that can be allocated between two independent channels: external progression (amplitude A) and internal cycling (amplitude B). Because the channels are independent, their combined amplitude is given by the Euclidean norm:

$$C_{\text{total}}^2 = A^2 + B^2. \tag{7}$$

Normalizing by setting $k = A/C_{\text{total}}$ and $R = B/C_{\text{total}}$ yields the fundamental quadratic closure:

$$k^2 + R^2 = 1. \tag{8}$$

When the system is at rest, $k = 0$ and $R = 1$. If it begins to progress (i.e., acquires a non-zero k), the internal share R must shrink to maintain the norm. The time required to complete one full internal cycle (one "closure") becomes stretched:

$$\frac{T_{\text{work}}}{T_{\text{rest}}} = \frac{1}{R} = \frac{1}{\sqrt{1-k^2}}. \tag{9}$$

This is exactly the Lorentz factor of special relativity, here derived purely from capacity reallocation without any mixing of space and time. Similarly, the progression length per tick is stretched by the same factor, preserving the invariant speed c.

3.4 Wave-Count Conservation in Gravitational Fields

A crucial principle for extending the model to curved spacetime is the invariance of total wave count under gravitational influence. Consider an isolated box containing a fixed number N of wave cycles. When the box is moved to a region of different gravitational potential, the locally measured frequency and wavelength change (gravitational redshift), but the number of cycles inside the box remains unchanged. This is because the box has exchanged no energy with the outside; the wave count is a topological invariant. In the eight-layer donut, the total wave count S_{total} is therefore independent of the environment, even though the perceived frequency may vary. This principle underlies the model's predictions for gravitational tests.

4 The Eight-Layer Donut Structure

With the foundational principles in place, we now construct the explicit layered architecture of the electron. The structure consists of eight concentric, mirror-symmetric layers. The fundamental scaling kernel is

$$\Xi = \frac{2}{\alpha} \approx 274.072, \tag{10}$$

where $\alpha \approx 1/137.036$ is the fine-structure constant. This number will appear repeatedly as the ratio between successive layer capacities.

4.1 Layer Capacities as Powers of Ξ

The base capacity C_i of layer i (the maximum number of wave tokens it can hold without initiating counter-rotation) is defined as:

$$\begin{aligned} C_1 &= 1, & (11)\\ C_2 &= \Xi, & (12)\\ C_3 &= \Xi^2, & (13)\\ C_4 &= \Xi^4, & (14)\\ C_5 &= \Xi^4, & (15)\\ C_6 &= \Xi^2, & (16)\\ C_7 &= \Xi, & (17)\\ C_8 &= 1. & (18) \end{aligned}$$

The mirror symmetry $C_i = C_{9-i}$ is evident. The actual wave content w_i of each layer includes not only its own base capacity but also the capacity of the adjacent inner layer, reflecting the inward cascade of surplus waves:

$$\begin{aligned} w_1 &= \Xi + 1, & (19)\\ w_2 &= \Xi^2 + \Xi, & (20)\\ w_3 &= \Xi^4 + \Xi^2, & (21)\\ w_4 &= \Xi^8 + \Xi^4, & (22) \end{aligned}$$

and by symmetry $w_5 = w_4$, $w_6 = w_3$, $w_7 = w_2$, $w_8 = w_1$.

4.2 Why Eight Layers?

The number eight is not arbitrary; it follows directly from the ladder parameters and the stability condition that the innermost layer must lie above the Planck floor. From the ladder calibration, the total logarithmic span from the innermost stable layer (which must have a rank of at least ≈ 8 to avoid Planck-scale collapse) to the outermost layer (rank $r_{\text{current}} \approx 76.99$) is

$$\Delta r_{\text{total}} = r_{\text{current}} - r_{\text{min}} \approx 76.99 - 8 = 68.99. \tag{23}$$

The outermost gap (between layer7 and layer8) is fixed by the ratio Ξ:

$$\Delta r_{\text{adj}} = \log_2(\Xi) \approx 8.1. \tag{24}$$

If there were seven layers, the total span would be at most $6 \times 8.1 = 48.6$, which is far too small. If there were nine layers, the total span would be at least $8 \times 8.1 = 64.8$, still less than 68.99, and the inner layers would need to have gaps larger than 8.1. In fact, the remaining six gaps (between layers 1–2, 2–3, 3–4, 4–5, 5–6, 6–7) must sum to $68.99 - 8.1 = 60.89$, giving an average inner gap of about 10.15. This non-uniform scaling (larger inner gaps) is physically plausible because inner layers are more compressed. Only eight layers can accommodate the required total span while keeping the innermost layer above the stability threshold.

4.3 Total Wave Count and the 3% Inertial Margin

Summing the wave content of all eight layers yields the total wave number:

$$\begin{aligned} S_{\text{total}} &= 2(w_1 + w_2 + w_3 + w_4) && (25) \\ &= 2\left[(\Xi + 1) + (\Xi^2 + \Xi) + (\Xi^4 + \Xi^2) + (\Xi^8 + \Xi^4)\right] && (26) \\ &= 2\left(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1\right). && (27) \end{aligned}$$

Using the CODATA 2018 value $\alpha^{-1} = 137.035999177$, we compute $\Xi = 274.071998354$ and obtain numerically:

$$S_{\text{total}} \approx 6.367178 \times 10^{19}. \tag{28}$$

The frequency of a photon whose energy equals the electron rest mass is

$$\nu = \frac{m_e c^2}{h} \approx 1.235590 \times 10^{20}\,\text{Hz}, \tag{29}$$

so half this frequency is $\nu/2 \approx 6.17795 \times 10^{19}\,\text{Hz}$. The difference,

$$\Delta = S_{\text{total}} - \frac{\nu}{2} \approx 1.8923 \times 10^{18}, \tag{30}$$

represents a relative excess of about 3.06%. This excess is not an error or a fitting parameter; it is a structural necessity. It corresponds to the amount of "idle" wave content that must be overcome before the electron as a whole can accelerate – in other words, it is the origin of inertia.

4.4 The 7.8 keV Inertial Margin

The energy equivalent of this excess wave count is

$$E_{\text{margin}} = h\Delta \approx 7.826\,\text{keV}. \tag{31}$$

This places the inertial margin in the soft X-ray region. If this margin is real, it should manifest as a resonance in electron–photon scattering at exactly this energy. A detailed experimental proposal is given in Sec. G.

5 Dynamics and Symmetry

The static layer structure must be supplemented by dynamical principles that govern stability, motion, and the emergence of observable quantities.

5.1 Phase Locking and the Critical Angle

The two innermost layers (layers1 and2) are assumed to be counter-rotating. Their relative phase difference $\Delta\theta$ determines the stability of the entire configuration. As long as $\Delta\theta$ remains below a critical value θ_{critical}, the layers remain phase-locked and the electron is stable. When $\Delta\theta$ reaches θ_{critical}, the lock breaks and energy redistributes – this could correspond to excitation or decay.

It is important to note that the exact numerical value of θ_{critical} is not given by the model. The geometric construction of a single ladder step (ratio 2) yields $\arctan(1/2) \approx 26.5^\circ$, which is a natural candidate, but the actual threshold may differ and must be determined either by a more detailed dynamical calculation or by experiment. Therefore, any mention of 26.5° in the accompanying blocks should be interpreted as a placeholder, not as a firm prediction.

5.2 Phase-Decoupling Radius

The influence of a layer's internal phase on outer layers decays with distance. Analysis of the hydrogen ground-state resonance suggests that when the scale separation reaches Ξ (in dimensionless units), the coupling becomes negligible. Thus the scale 274 can be interpreted as a phase-decoupling radius: for radii larger than this, the inner layers become observationally silent.

This explains why the innermost structure of the electron does not appear in low-energy experiments – it is hidden behind a phase boundary.

5.3 Phase Visibility Boundary and Wave-Particle Duality

The scale $274 = 2/\alpha$ can also be viewed as a phase visibility boundary. Layers inside this boundary (layers1–7) oscillate, but their phase is not detectable externally; they contribute only to the electron's mass. Layer8 lies outside the boundary, making its phase fully visible – this is the wave aspect of the electron. Thus the model offers a geometric origin for wave-particle duality.

5.4 Asymmetry-Driven Linear Motion

The inner layers rotate faster than the outer ones, creating a persistent angular velocity gradient. Conservation of angular momentum, together with phase-locking constraints, forces the whole structure to acquire a linear velocity perpendicular to the rotation axis. This is the origin of inertia and of the "Wounded Serpent" intuition: the coiled serpent springs forward when its internal twist becomes too great. Moreover, if the geometric center does not coincide with the center of mass (due to layer asymmetry), the center of mass traces a helical path when the electron moves. The helix amplitude is of order the classical electron radius, and its pitch is of order the Compton wavelength. These effects might be observable in ultra-high-precision beam experiments.

6 The Fine-Structure Constant as a Geometric Kernel

The fine-structure constant α generates a consistent hierarchy of scales that appear repeatedly in atomic physics and in our model:

$$\alpha^{-1} \approx 137 \quad \text{(spatial scale bridge: Bohr circumference / Compton wavelength)}, \tag{32}$$

$$2\alpha^{-1} \approx 274 \quad \text{(phase visibility boundary and kernel } \Xi\text{)}, \tag{33}$$

$$\alpha^{-2} \approx 19000 \quad \text{(internal phase cycles per atomic orbit)}. \tag{34}$$

These numbers are not independent; they follow from a single constant α and the geometry of the system. In particular, the number 19000 arises from the ratio of the orbital period of the electron in the hydrogen ground state to its internal tick time:

$$\frac{T_{\text{orbit}}}{T_{\text{tick}}} = \frac{2\pi a_0/(\alpha c)}{\lambda_C/c} = \frac{2\pi a_0}{\lambda_C} \cdot \frac{1}{\alpha} = \frac{1}{\alpha} \cdot \frac{1}{\alpha} = \frac{1}{\alpha^2} \approx 19000. \tag{35}$$

Thus, during one atomic orbit, the electron's internal oscillatory process ticks about 19000 times. This number is not a coincidence; it is a direct consequence of the scale relations encoded in α.

7 Experimental Predictions

The eight-layer donut model makes two main experimental predictions, both of which are falsifiable with current technology.

7.1 Resonant X-Ray Scattering at 7.8 keV

The inertial margin $E_{\text{margin}} \approx 7.8\,\text{keV}$ corresponds to an internal excitation mode. When an incoming photon has this energy, resonant enhancement of the scattering cross-section should occur. A suitable experimental setup would use a tunable synchrotron or X-ray free-electron laser to scan the energy range 7.5–8.1keV with high resolution (0.5eV or better). The target should be a low-Z material with nearly free electrons and no strong absorption edges near 7.8keV – thin beryllium foil or a gas jet (helium or hydrogen) are ideal. A fixed-angle detector (e.g., at 90°) would record scattered X-rays. A positive signal would appear as a sharp, narrow peak at exactly 7.826 keV above a smooth background. A null result would place an upper limit on the coupling strength between the photon and the internal layer mode, thereby constraining the model.

7.2 Gravitational Redshift Anomaly

If the 7.8keV margin couples to gravity, the effective electron mass depends slightly on the gravitational potential Φ. For two identical atomic clocks at different potentials, the frequency ratio acquires an extra term:

$$\frac{\Delta\nu}{\nu} \approx \eta \cdot 1.53 \times 10^{-2} \frac{\Delta\Phi}{c^2}, \tag{36}$$

where η is an order-unity coupling constant if the coupling is full. A satellite mission such as STE-QUEST, with $\Delta\Phi/c^2 \sim 10^{-9}$ and a target accuracy of 10^{-18}, could detect a signal $\sim 10^{-11}$. A null result would constrain $|\eta| < 10^{-7}$, effectively ruling out any significant coupling.

8 Conclusion and Outlook

We have presented a complete, parameter-free geometric model of the electron. The model derives the electron's mass from closed-path quantization and a binary ladder anchored at the Planck scale. An eight-layer mirror-symmetric structure with capacities as powers of $\Xi = 2/\alpha$ yields a total wave count $S_{\text{total}} \approx 6.367 \times 10^{19}$, exceeding half the Compton frequency by 3%. This excess translates into an inertial margin of 7.8 keV, which predicts a resonance in X-ray scattering. The model also explains the origin of electric charge (as the sign of the residual field from an asymmetric gamma collision), the Pauli exclusion principle (through finite layer capacities), and the hierarchy of scales generated by the fine-structure constant. Wave-particle duality finds a geometric interpretation via the phase visibility boundary at 274.

The model is strictly about the electron; any speculative remarks about other particles in the accompanying documentation are not part of the core theory. All predictions are falsifiable and within reach of current experimental technology. A full numerical solution of the underlying field equations remains a task for the future, but the conceptual framework is now complete and ready for scrutiny.

References

[1] IRCBHC Block FLR-01, "Frame Ladder Root" (2026).

[2] IRCBHC Block CNR-01, "Capacity Norm" (2026).

[3] IRCBHC Block TWC-01, "Total Wave Count and 3% Margin" (2026).

[4] IRCBHC Block MEI-01, "Margin Energy Interpretation" (2026).

[5] IRCBHC Block EXP-FINAL-7.8keV, "Final 7.8keV Experimental Proposal" (2026).

[6] IRCBHC Block EXP-GRAV-01, "Atomic Clock Gravity Test" (2026).

[7] IRCBHC Block PVB-01, "Phase Visibility Boundary" (2026).

[8] IRCBHC Block ASL-01, "Alpha Scale Ladder" (2026).

[9] IRCBHC Block ART-106, "Why a High-Energy Photon Cannot Fully Collapse into Rest Mass" (2026).

"'latex

9 Conclusion and Outlook

We have presented a complete, parameter-free geometric model of the electron. Starting from the simple intuition of the Wounded Serpent, we derived a set of foundational principles: closed-path quantization, a binary ladder of scales anchored at the Planck length, the capacity norm that yields the Lorentz factor, and the invariance of wave count under gravitational influence. These principles lead uniquely to an eight-layer mirror-symmetric structure whose layer capacities are powers of $\Xi = 2/\alpha$.

The total wave count $S_{\text{total}} = 2(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1) \approx 6.367 \times 10^{19}$ exceeds half the Compton frequency of the electron by about 3%. This excess is not an error but a structural necessity – it is the inertial margin, the amount of internal wave content that must be overcome before the electron can accelerate. Its energy equivalent $E_{\text{margin}} = h\Delta \approx 7.8\,\text{keV}$ is a falsifiable prediction that can be tested by resonant X-ray scattering experiments.

The model also accounts for several other fundamental features of the electron:

- **Electric charge** arises from the sign of the residual field left after an asymmetric gamma collision, with the residual fraction 1/274 inherited from the ladder scale separation. The opposite signs of electron and positron correspond to the two possible chiralities of the collision.

- **The Pauli exclusion principle** emerges naturally from the finite capacities of each layer combined with the two spin states; once a layer is full, no additional electron can occupy it.

- **Wave-particle duality** finds a geometric interpretation through the phase visibility boundary at $274 = 2/\alpha$. Layers inside this boundary (layers1–7) oscillate but their phase is hidden; they contribute only to the electron's mass. Layer8 lies outside the boundary, making its phase fully visible – this is the wave aspect.

- **The fine-structure constant** appears as the fundamental geometric kernel that generates the hierarchy of scales: $\alpha^{-1} \approx 137$ (spatial bridge), $2\alpha^{-1} \approx 274$ (phase boundary), and $\alpha^{-2} \approx 19000$ (internal cycles per atomic orbit).

It is crucial to emphasize that this model is developed strictly for the electron. Any discussion in the accompanying blocks about extensions to muons, taus, or other particles is purely speculative and not part of the core theory. The model stands or falls on its predictions for the electron alone.

9.1 Limitations and Open Questions

While the model is conceptually complete and internally consistent, several important tasks remain for future work:

- A full numerical solution of the coupled field equations (outlined in blocks LAG-EOM-02 and LAG-SOLVE-03) is needed to confirm that the eight-layer structure indeed emerges from a dynamical principle and to compute the exact layer profiles.

- The critical angle θ_{critical} at which the internal phase lock breaks remains undetermined; its value must be obtained either from a more detailed dynamical calculation or from experiment.

- The precise numerical value of the electron's g-factor has not been derived; we have only a qualitative explanation of why it is close to 2 and why a small anomaly exists. A full calculation would require solving the coupled field equations and is a major research project in itself.

- The connection to quantum field theory (QED) is not yet established; the model currently operates at a classical or semi-classical level. Whether it can be quantized to reproduce the full apparatus of QED remains an open question.

9.2 Outlook

Despite these open questions, the eight-layer donut model offers a coherent, falsifiable, and parameter-free description of the electron. Its main predictions – the 7.8 keV resonance and the gravitational redshift anomaly – are within reach of current experimental technology. A positive detection would revolutionize our understanding of the electron and provide strong support for the geometric approach to fundamental physics. Even a null result would be valuable, placing upper limits on the coupling strength and guiding future theoretical developments.

The model is ready for scrutiny by the broader physics community. All supporting documentation, including 45 detailed blocks covering every aspect of the derivation, is provided in the accompanying archive. We hope that this work will stimulate both experimental tests and further theoretical investigations into the geometric origin of mass and charge.

References

[1] IRCBHC Block FLR-01, "Frame Ladder Root" (2026).

[2] IRCBHC Block CNR-01, "Capacity Norm" (2026).

[3] IRCBHC Block TWC-01, "Total Wave Count and 3% Margin" (2026).

[4] IRCBHC Block MEI-01, "Margin Energy Interpretation" (2026).

[5] IRCBHC Block EXP-FINAL-7.8keV, "Final 7.8keV Experimental Proposal" (2026).

[6] IRCBHC Block EXP-GRAV-01, "Atomic Clock Gravity Test" (2026).

[7] IRCBHC Block PVB-01, "Phase Visibility Boundary" (2026).

[8] IRCBHC Block ASL-01, "Alpha Scale Ladder" (2026).

[9] IRCBHC Block ART-106, "Why a High-Energy Photon Cannot Fully Collapse into Rest Mass" (2026).

[10] IRCBHC Block LCD-01, "Layer Count Derivation" (2026).

[11] IRCBHC Block CRIT-ANG-CLR-01, “Critical Angle Clarification” (2026).

[12] IRCBHC Block RET-EXT-01, “Retraction of Extensions” (2026).

“‘latex

A List of Supporting Blocks

The complete documentation of the eight-layer donut model consists of 45 self-contained blocks, each with a unique identifier, version, and purpose. These blocks are available for download at the following URL:
`https://zenodo.org/records/18937962/files/IRCBHC_EightLayerDonut_Blocks.zip?download=1`

Below we list the most essential blocks referenced in this paper. For a full index, including all 45 blocks and their dependencies, the reader is referred to the Zenodo archive.

For a complete list of all 45 blocks, including meta-documentation, Lagrangian sketches, and speculative remarks (which are not part of the core model), please consult the Zenodo archive. The blocks are named sequentially and can be read independently; a README file (block PKG-README-01) provides a navigation guide.

“‘latex

[12pt]article amsmath, amssymb, graphicx hyperref [utf8]inputenc geometry a4paper, margin=1in

The Eight-Layer Donut Model: A Geometric Derivation of the Electron Mass

Parameter-Free Predictions and Experimental Tests S. M. H. Emamifar, Z. Derakhshani
IRCBHC Collaboration March 2026

Abstract

We present a complete, parameter-free geometric model of the electron. Starting from closed-path quantization and a binary ladder of scales anchored at the Planck length, we derive an eight-layer mirror-symmetric structure. The layer capacities are powers of $\Xi = 2/\alpha$, leading to a total wave count $S_{\text{total}} = 2(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1)$.

The excess over half the Compton frequency, about 3%, gives an inertial margin of 7.8 keV, which predicts a resonance in electron–photon scattering. The model also explains the origin of electric charge, the Pauli exclusion principle, and the hierarchy of scales generated by the fine-structure constant. All predictions are falsifiable and within reach of current experimental technology.

Contents

B Introduction: The Wounded Serpent Intuition

The origin of rest mass remains one of the deepest questions in physics. While the Standard Model introduces mass through the Higgs mechanism, it does not explain why the electron has exactly 0.511 MeV/c^2. The eight-layer donut model offers a different perspective: mass emerges from the confinement of a wave on a closed path, together with a hierarchical layered structure whose scales are set by the fine-structure constant α and the Planck length. The model is entirely parameter-free; once α, $\hbar$, c, and the Planck scale are fixed, the electron mass is uniquely determined.

B.1 The Wounded Serpent: An Intuitive Starting Point

The model originates from a simple geometric intuition, which we call the "Wounded Serpent". Imagine two high-energy photons (each with energy 0.511 MeV) approaching each other in a nearly head-on collision, but with a slight transverse offset. In the overlap region, the peaks of one photon almost coincide with the troughs of the other, leading to nearly complete cancellation. However, because the collision is not perfectly centered, a small residual field remains. This residual, which is about 1/274 of the original amplitude, creates an asymmetry – a "wound" – that forces part of the electromagnetic field to curve and close upon itself. Thus, instead of continuing as free radiation, the field forms a closed loop. This closed loop is the seed of the electron's rest mass.

This intuition naturally leads to a two-scale structure: a highly compressed inner region (the "head" of the serpent) and a larger, circulating outer region (the "tail"). The inner region will eventually become the core of the electron, while the outer region will become its wave-like envelope. The number 274 that appears here is not arbitrary; it will later be identified with $2/\alpha$, where α is the fine-structure constant.

B.2 Why a Single-Scale Confinement Fails

One might naïvely think that a single closed loop of light could represent the electron. However, as shown in Article #106 (block ART-106), this idea fails quantitatively. If the entire energy of a 0.511 MeV photon were confined to a region much smaller than its wavelength, the required phase-wrapping factor would be enormous (on the order of 10^5). Moreover, if electric charge were also confined to such a tiny core, its electromagnetic self-energy would be hundreds of MeV, far exceeding the electron's total energy. Therefore, the electron cannot be a single-scale object; it must have at least two distinct scales: a compact core that carries most of the mass, and an extended region that supports the charge. This necessity is the foundational motivation for the eight-layer donut model.

B.3 Scope of the Model

It is important to emphasize that this model is developed strictly for the electron. The eight-layer structure is derived specifically from the electron's properties and does not automatically apply to other particles. In the accompanying block package, there are informal discussions exploring whether similar layered structures might exist for muons, taus, or other particles. These are not part of the core model—they are speculative remarks included to stimulate discussion and should be treated as such. The core model stands independently and makes no claims about any particle other than the electron.

C Foundational Principles

Before constructing the eight-layer structure, we must establish the foundational principles on which the model rests. These principles are purely operational and rely on counting and geometry rather than on imported physical assumptions.

C.1 Closed-Path Quantization

Consider a relativistic wave confined to a closed path of length L. For the wavefunction to be single-valued, the total phase accumulated over one full traversal must be an integer multiple of 2π:

$$kL = 2\pi n, \quad n \in \mathbb{Z}. \tag{37}$$

Here $k = 2\pi/\lambda$ is the wave number. For the lowest mode $n = 1$, we have $L = \lambda$. The energy of such a mode is $E = \hbar ck = \hbar c/R$ where $L = 2\pi R$. Identifying this with the rest energy mc^2 yields the fundamental mass-radius relation:

$$m = \frac{\hbar}{Rc}. \tag{38}$$

Thus mass is not an intrinsic property but a consequence of confinement on a closed path. This relation will be used repeatedly in the following sections.

C.2 Frame Ladder and the Planck Anchor

We introduce a discrete ladder of frames (ranks) indexed by a continuous rank r, with $r = 0$ corresponding to the Planck floor. Each step up the ladder doubles both the length unit and the time unit:

$$L(r) = l_P\, 2^r, \qquad T(r) = t_P\, 2^r, \tag{39}$$

where $l_P = \sqrt{\hbar G/c^3} \approx 1.616 \times 10^{-35}\,\mathrm{m}$ and $t_P = l_P/c \approx 5.391 \times 10^{-44}\,\mathrm{s}$ are the Planck length and time. An immediate consequence is that the ratio $L(r)/T(r) = l_P/t_P = c$ is invariant across all frames. This provides an operational origin for the constancy of the speed of light without invoking spacetime geometry.

Our physical frame is identified by matching the step length to the reduced Compton wavelength of the electron:

$$L_{\text{step}} \equiv \frac{\lambda_C}{2\pi} = \frac{\hbar}{m_e c} \approx 3.8616 \times 10^{-13}\,\mathrm{m}. \tag{40}$$

One "tick" in our frame is the time required for light to travel one step length:

$$T_{\text{tick}} = \frac{L_{\text{step}}}{c} \approx 8.0933 \times 10^{-21}\,\mathrm{s}. \tag{41}$$

The rank of our frame relative to the Planck floor is then

$$r_{\text{current}} = \log_2\left(\frac{L_{\text{step}}}{l_P}\right) = \log_2\left(\frac{T_{\text{tick}}}{t_P}\right) \approx 76.99. \tag{42}$$

This number will appear later in the calibration of layer capacities.

C.3 Capacity Norm and the Origin of Lorentz Factors

Each tick carries a fixed total "capacity" C_{total} that can be allocated between two independent channels: external progression (amplitude A) and internal cycling (amplitude B). Because the channels are independent, their combined amplitude is given by the Euclidean norm:

$$C_{\text{total}}^2 = A^2 + B^2. \tag{43}$$

Normalizing by setting $k = A/C_{\text{total}}$ and $R = B/C_{\text{total}}$ yields the fundamental quadratic closure:

$$k^2 + R^2 = 1. \tag{44}$$

When the system is at rest, $k = 0$ and $R = 1$. If it begins to progress (i.e., acquires a non-zero k), the internal share R must shrink to maintain the norm. The time required to complete one full internal cycle (one "closure") becomes stretched:

$$\frac{T_{\text{work}}}{T_{\text{rest}}} = \frac{1}{R} = \frac{1}{\sqrt{1-k^2}}. \tag{45}$$

This is exactly the Lorentz factor of special relativity, here derived purely from capacity reallocation without any mixing of space and time. Similarly, the progression length per tick is stretched by the same factor, preserving the invariant speed c.

C.4 Wave-Count Conservation in Gravitational Fields

A crucial principle for extending the model to curved spacetime is the invariance of total wave count under gravitational influence. Consider an isolated box containing a fixed number N of wave cycles. When the box is moved to a region of different gravitational potential, the locally measured frequency and wavelength change (gravitational redshift), but the number of cycles inside the box remains unchanged. This is because the box has exchanged no energy with the outside; the wave count is a topological invariant. In the eight-layer donut, the total wave count S_{total} is therefore independent of the environment, even though the perceived frequency may vary. This principle underlies the model's predictions for gravitational tests.

D The Eight-Layer Donut Structure

With the foundational principles in place, we now construct the explicit layered architecture of the electron. The structure consists of eight concentric, mirror-symmetric layers. The fundamental scaling kernel is

$$\Xi = \frac{2}{\alpha} \approx 274.072, \tag{46}$$

where $\alpha \approx 1/137.036$ is the fine-structure constant. This number will appear repeatedly as the ratio between successive layer capacities.

D.1 Layer Capacities as Powers of Ξ

The base capacity C_i of layer i (the maximum number of wave tokens it can hold without initiating counter-rotation) is defined as:

$$C_1 = 1, \tag{47}$$
$$C_2 = \Xi, \tag{48}$$
$$C_3 = \Xi^2, \tag{49}$$
$$C_4 = \Xi^4, \tag{50}$$
$$C_5 = \Xi^4, \tag{51}$$
$$C_6 = \Xi^2, \tag{52}$$
$$C_7 = \Xi, \tag{53}$$
$$C_8 = 1. \tag{54}$$

The mirror symmetry $C_i = C_{9-i}$ is evident. The actual wave content w_i of each layer includes not only its own base capacity but also the capacity of the adjacent inner layer, reflecting the inward cascade of surplus waves:

$$w_1 = \Xi + 1, \tag{55}$$
$$w_2 = \Xi^2 + \Xi, \tag{56}$$
$$w_3 = \Xi^4 + \Xi^2, \tag{57}$$
$$w_4 = \Xi^8 + \Xi^4, \tag{58}$$

and by symmetry $w_5 = w_4$, $w_6 = w_3$, $w_7 = w_2$, $w_8 = w_1$.

D.2 Why Eight Layers?

The number eight is not arbitrary; it follows directly from the ladder parameters and the stability condition that the innermost layer must lie above the Planck floor. From the ladder calibration, the total logarithmic span from the innermost stable layer (which must have a rank of at least ≈ 8 to avoid Planck-scale collapse) to the outermost layer (rank $r_{\text{current}} \approx 76.99$) is

$$\Delta r_{\text{total}} = r_{\text{current}} - r_{\text{min}} \approx 76.99 - 8 = 68.99. \tag{59}$$

The outermost gap (between layer7 and layer8) is fixed by the ratio Ξ:

$$\Delta r_{\text{adj}} = \log_2(\Xi) \approx 8.1. \tag{60}$$

If there were seven layers, the total span would be at most $6 \times 8.1 = 48.6$, which is far too small. If there were nine layers, the total span would be at least $8 \times 8.1 = 64.8$, still less than 68.99, and the inner layers would need to have gaps larger than 8.1. In fact, the remaining six gaps (between layers 1–2, 2–3, 3–4, 4–5, 5–6, 6–7) must sum to $68.99 - 8.1 = 60.89$, giving an average inner gap of about 10.15. This non-uniform scaling (larger inner gaps) is physically plausible because inner layers are more compressed. Only eight layers can accommodate the required total span while keeping the innermost layer above the stability threshold.

D.3 Total Wave Count and the 3% Inertial Margin

Summing the wave content of all eight layers yields the total wave number:

$$\begin{aligned} S_{\text{total}} &= 2(w_1 + w_2 + w_3 + w_4) && (61)\\ &= 2\left[(\Xi + 1) + (\Xi^2 + \Xi) + (\Xi^4 + \Xi^2) + (\Xi^8 + \Xi^4)\right] && (62)\\ &= 2\left(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1\right). && (63)\end{aligned}$$

Using the CODATA 2018 value $\alpha^{-1} = 137.035999177$, we compute $\Xi = 274.071998354$ and obtain numerically:

$$S_{\text{total}} \approx 6.367178 \times 10^{19}. \tag{64}$$

The frequency of a photon whose energy equals the electron rest mass is

$$\nu = \frac{m_e c^2}{h} \approx 1.235590 \times 10^{20}\,\mathrm{Hz}, \tag{65}$$

so half this frequency is $\nu/2 \approx 6.17795 \times 10^{19}\,\mathrm{Hz}$. The difference,

$$\Delta = S_{\text{total}} - \frac{\nu}{2} \approx 1.8923 \times 10^{18}, \tag{66}$$

represents a relative excess of about 3.06%. This excess is not an error or a fitting parameter; it is a structural necessity. It corresponds to the amount of "idle" wave content that must be overcome before the electron as a whole can accelerate – in other words, it is the origin of inertia.

D.4 The 7.8 keV Inertial Margin

The energy equivalent of this excess wave count is

$$E_{\text{margin}} = h\Delta \approx 7.826\,\mathrm{keV}. \tag{67}$$

This places the inertial margin in the soft X-ray region. If this margin is real, it should manifest as a resonance in electron–photon scattering at exactly this energy. A detailed experimental proposal is given in Sec. G.

E Dynamics and Symmetry

The static layer structure must be supplemented by dynamical principles that govern stability, motion, and the emergence of observable quantities.

E.1 Phase Locking and the Critical Angle

The two innermost layers (layers1 and2) are assumed to be counter-rotating. Their relative phase difference $\Delta\theta$ determines the stability of the entire configuration. As long as $\Delta\theta$ remains below a critical value θ_{critical}, the layers remain phase-locked and the electron is stable. When $\Delta\theta$ reaches θ_{critical}, the lock breaks and energy redistributes – this could correspond to excitation or decay.

It is important to note that the exact numerical value of θ_{critical} is not given by the model. The geometric construction of a single ladder step (ratio

2) yields arctan(1/2) $\approx 26.5^\circ$, which is a natural candidate, but the actual threshold may differ and must be determined either by a more detailed dynamical calculation or by experiment. Therefore, any mention of 26.5° in the accompanying blocks should be interpreted as a placeholder, not as a firm prediction.

E.2 Phase-Decoupling Radius

The influence of a layer's internal phase on outer layers decays with distance. Analysis of the hydrogen ground-state resonance suggests that when the scale separation reaches Ξ (in dimensionless units), the coupling becomes negligible. Thus the scale 274 can be interpreted as a phase-decoupling radius: for radii larger than this, the inner layers become observationally silent. This explains why the innermost structure of the electron does not appear in low-energy experiments – it is hidden behind a phase boundary.

E.3 Phase Visibility Boundary and Wave-Particle Duality

The scale $274 = 2/\alpha$ can also be viewed as a phase visibility boundary. Layers inside this boundary (layers1–7) oscillate, but their phase is not detectable externally; they contribute only to the electron's mass. Layer8 lies outside the boundary, making its phase fully visible – this is the wave aspect of the electron. Thus the model offers a geometric origin for wave-particle duality.

E.4 Asymmetry-Driven Linear Motion

The inner layers rotate faster than the outer ones, creating a persistent angular velocity gradient. Conservation of angular momentum, together with phase-locking constraints, forces the whole structure to acquire a linear velocity perpendicular to the rotation axis. This is the origin of inertia and of the "Wounded Serpent" intuition: the coiled serpent springs forward when its internal twist becomes too great. Moreover, if the geometric center does not coincide with the center of mass (due to layer asymmetry), the center of mass traces a helical path when the electron moves. The helix amplitude is of order the classical electron radius, and its pitch is of order the Compton wavelength. These effects might be observable in ultra-high-precision beam experiments.

F The Fine-Structure Constant as a Geometric Kernel

The fine-structure constant α generates a consistent hierarchy of scales that appear repeatedly in atomic physics and in our model:

$$\alpha^{-1} \approx 137 \quad \text{(spatial scale bridge: Bohr circumference / Compton wavelength)}, \tag{68}$$

$$2\alpha^{-1} \approx 274 \quad \text{(phase visibility boundary and kernel } \Xi\text{)}, \tag{69}$$

$$\alpha^{-2} \approx 19000 \quad \text{(internal phase cycles per atomic orbit)}. \tag{70}$$

These numbers are not independent; they follow from a single constant α and the geometry of the system. In particular, the number 19000 arises from the ratio of the orbital period of the electron in the hydrogen ground state to its internal tick time:

$$\frac{T_{\text{orbit}}}{T_{\text{tick}}} = \frac{2\pi a_0/(\alpha c)}{\lambda_C/c} = \frac{2\pi a_0}{\lambda_C} \cdot \frac{1}{\alpha} = \frac{1}{\alpha} \cdot \frac{1}{\alpha} = \frac{1}{\alpha^2} \approx 19000. \tag{71}$$

Thus, during one atomic orbit, the electron's internal oscillatory process ticks about 19000 times. This number is not a coincidence; it is a direct consequence of the scale relations encoded in α.

G Experimental Predictions

The eight-layer donut model makes two main experimental predictions, both of which are falsifiable with current technology.

G.1 Resonant X-Ray Scattering at 7.8 keV

The inertial margin $E_{\text{margin}} \approx 7.8\,\text{keV}$ corresponds to an internal excitation mode. When an incoming photon has this energy, resonant enhancement of the scattering cross-section should occur. A suitable experimental setup would use a tunable synchrotron or X-ray free-electron laser to scan the energy range 7.5–8.1keV with high resolution (0.5eV or better). The target should be a low-Z material with nearly free electrons and no strong absorption edges near 7.8keV – thin beryllium foil or a gas jet (helium or hydrogen) are ideal. A fixed-angle detector (e.g., at 90°) would record scattered X-rays.

A positive signal would appear as a sharp, narrow peak at exactly 7.826 keV above a smooth background. A null result would place an upper limit on the coupling strength between the photon and the internal layer mode, thereby constraining the model.

G.2 Gravitational Redshift Anomaly

If the 7.8keV margin couples to gravity, the effective electron mass depends slightly on the gravitational potential Φ. For two identical atomic clocks at different potentials, the frequency ratio acquires an extra term:

$$\frac{\Delta\nu}{\nu} \approx \eta \cdot 1.53 \times 10^{-2} \frac{\Delta\Phi}{c^2}, \tag{72}$$

where η is an order-unity coupling constant if the coupling is full. A satellite mission such as STE-QUEST, with $\Delta\Phi/c^2 \sim 10^{-9}$ and a target accuracy of 10^{-18}, could detect a signal $\sim 10^{-11}$. A null result would constrain $|\eta| < 10^{-7}$, effectively ruling out any significant coupling.

H Conclusion and Outlook

We have presented a complete, parameter-free geometric model of the electron. Starting from the simple intuition of the Wounded Serpent, we derived a set of foundational principles: closed-path quantization, a binary ladder of scales anchored at the Planck length, the capacity norm that yields the Lorentz factor, and the invariance of wave count under gravitational influence. These principles lead uniquely to an eight-layer mirror-symmetric structure whose layer capacities are powers of $\Xi = 2/\alpha$.

The total wave count $S_{\text{total}} = 2(\Xi^8 + 2\Xi^4 + 2\Xi^2 + 2\Xi + 1) \approx 6.367 \times 10^{19}$ exceeds half the Compton frequency of the electron by about 3%. This excess is not an error but a structural necessity – it is the inertial margin, the amount of internal wave content that must be overcome before the electron can accelerate. Its energy equivalent $E_{\text{margin}} = h\Delta \approx 7.8\,\text{keV}$ is a falsifiable prediction that can be tested by resonant X-ray scattering experiments.

The model also accounts for several other fundamental features of the electron:

- **Electric charge** arises from the sign of the residual field left after an asymmetric gamma collision, with the residual fraction 1/274 inherited from the ladder scale separation. The opposite signs of electron and positron correspond to the two possible chiralities of the collision.

- **The Pauli exclusion principle** emerges naturally from the finite capacities of each layer combined with the two spin states; once a layer is full, no additional electron can occupy it.
- **Wave-particle duality** finds a geometric interpretation through the phase visibility boundary at $274 = 2/\alpha$. Layers inside this boundary (layers1–7) oscillate but their phase is hidden; they contribute only to the electron's mass. Layer8 lies outside the boundary, making its phase fully visible – this is the wave aspect.
- **The fine-structure constant** appears as the fundamental geometric kernel that generates the hierarchy of scales: $\alpha^{-1} \approx 137$ (spatial bridge), $2\alpha^{-1} \approx 274$ (phase boundary), and $\alpha^{-2} \approx 19000$ (internal cycles per atomic orbit).

It is crucial to emphasize that this model is developed strictly for the electron. Any discussion in the accompanying blocks about extensions to muons, taus, or other particles is purely speculative and not part of the core theory. The model stands or falls on its predictions for the electron alone.

H.1 Limitations and Open Questions

While the model is conceptually complete and internally consistent, several important tasks remain for future work:

- A full numerical solution of the coupled field equations (outlined in blocks LAG-EOM-02 and LAG-SOLVE-03) is needed to confirm that the eight-layer structure indeed emerges from a dynamical principle and to compute the exact layer profiles.
- The critical angle θ_{critical} at which the internal phase lock breaks remains undetermined; its value must be obtained either from a more detailed dynamical calculation or from experiment.
- The precise numerical value of the electron's g-factor has not been derived; we have only a qualitative explanation of why it is close to 2 and why a small anomaly exists. A full calculation would require

solving the coupled field equations and is a major research project in itself.

- The connection to quantum field theory (QED) is not yet established; the model currently operates at a classical or semi-classical level. Whether it can be quantized to reproduce the full apparatus of QED remains an open question.

H.2 Outlook

Despite these open questions, the eight-layer donut model offers a coherent, falsifiable, and parameter-free description of the electron. Its main predictions – the 7.8 keV resonance and the gravitational redshift anomaly – are within reach of current experimental technology. A positive detection would revolutionize our understanding of the electron and provide strong support for the geometric approach to fundamental physics. Even a null result would be valuable, placing upper limits on the coupling strength and guiding future theoretical developments.

The model is ready for scrutiny by the broader physics community. All supporting documentation, including 45 detailed blocks covering every aspect of the derivation, is provided in the accompanying archive. We hope that this work will stimulate both experimental tests and further theoretical investigations into the geometric origin of mass and charge.

A List of Supporting Blocks

The complete documentation of the eight-layer donut model consists of 45 self-contained blocks, each with a unique identifier, version, and purpose. These blocks are available for download at the following URL:
`https://zenodo.org/records/18937962/files/IRCBHC_EightLayerDonut_Blocks.zip?download=1`

Below we list the most essential blocks referenced in this paper. For a full index, including all 45 blocks and their dependencies, the reader is referred to the Zenodo archive.

For a complete list of all 45 blocks, including meta-documentation, Lagrangian sketches, and speculative remarks (which are not part of the core model), please consult the Zenodo archive. The blocks are named sequentially and can be read independently; a README file (block PKG-README-01) provides a navigation guide.

References

[1] IRCBHC Block FLR-01, "Frame Ladder Root" (2026).

[2] IRCBHC Block CNR-01, "Capacity Norm" (2026).

[3] IRCBHC Block TWC-01, "Total Wave Count and 3% Margin" (2026).

[4] IRCBHC Block MEI-01, "Margin Energy Interpretation" (2026).

[5] IRCBHC Block EXP-FINAL-7.8keV, "Final 7.8keV Experimental Proposal" (2026).

[6] IRCBHC Block EXP-GRAV-01, "Atomic Clock Gravity Test" (2026).

[7] IRCBHC Block PVB-01, "Phase Visibility Boundary" (2026).

[8] IRCBHC Block ASL-01, "Alpha Scale Ladder" (2026).

[9] IRCBHC Block ART-106, "Why a High-Energy Photon Cannot Fully Collapse into Rest Mass" (2026).

[10] IRCBHC Block LCD-01, "Layer Count Derivation" (2026).

[11] IRCBHC Block CRIT-ANG-CLR-01, "Critical Angle Clarification" (2026).

[12] IRCBHC Block RET-EXT-01, "Retraction of Extensions" (2026).

Block ID	Title / Brief Description
FLR-01	Frame Ladder Root – defines the binary ladder from Planck scale to Compton scale.
CNR-01	Capacity Norm – introduces $k^2 + R^2 = 1$ and the origin of the Lorentz factor.
TWC-01	Total Wave Count – computes S_{total} and the 3% margin.
MEI-01	Margin Energy Interpretation – derives the 7.8keV inertial margin.
ELC-01	Eight-Layer Capacities – defines layer capacities as powers of $\Xi = 2/\alpha$.
RSC-01	Resonance Condition – introduces the critical phase angle and lock mechanism.
PDC-01	Phase-Decoupling Radius – interprets the number 274 as a visibility boundary.
PVB-01	Phase Visibility Boundary – connects 274 to wave-particle duality.
ASL-01	Alpha Scale Ladder – explains the hierarchy $\alpha^{-1}, 2\alpha^{-1}, \alpha^{-2}$.
LCD-01	Layer Count Derivation – proves why eight layers are necessary.
CRIT-ANG-CLR-01	Critical Angle Clarification – corrects misunderstandings about θ_{critical}.
ALM-01	Asymmetry-Driven Linear Motion – shows how angular velocity gradient produces translation.
HEL-01	Helical Motion Derivation – computes helical trajectory parameters.
ART-106	Failure of Single-Scale Confinement – documents the necessity of two scales.
CHARGE-GC-01	Charge from Gamma Collision – explains the origin of electric charge.
PAULI-LAYERS-01	Pauli Exclusion from Layers – relates layer capacities to the exclusion principle.
EXP-FINAL-7.8keV	Final 7.8keV Experimental Proposal – detailed design for X-ray resonance search.
EXP-GRAV-01	Gravitational Redshift Anomaly – atomic clock test proposal.
RET-EXT-01	Retraction of Extensions – clarifies that the model applies only to the electron.

Block ID	Title / Brief Description
FLR-01	Frame Ladder Root – defines the binary ladder from Planck scale to Compton scale.
CNR-01	Capacity Norm – introduces $k^2 + R^2 = 1$ and the origin of the Lorentz factor.
TWC-01	Total Wave Count – computes S_{total} and the 3% margin.
MEI-01	Margin Energy Interpretation – derives the 7.8keV inertial margin.
ELC-01	Eight-Layer Capacities – defines layer capacities as powers of $\Xi = 2/\alpha$.
RSC-01	Resonance Condition – introduces the critical phase angle and lock mechanism.
PDC-01	Phase-Decoupling Radius – interprets the number 274 as a visibility boundary.
PVB-01	Phase Visibility Boundary – connects 274 to wave-particle duality.
ASL-01	Alpha Scale Ladder – explains the hierarchy $\alpha^{-1}, 2\alpha^{-1}, \alpha^{-2}$.
LCD-01	Layer Count Derivation – proves why eight layers are necessary.
CRIT-ANG-CLR-01	Critical Angle Clarification – corrects misunderstandings about θ_{critical}.
ALM-01	Asymmetry-Driven Linear Motion – shows how angular velocity gradient produces translation.
HEL-01	Helical Motion Derivation – computes helical trajectory parameters.
ART-106	Failure of Single-Scale Confinement – documents the necessity of two scales.
CHARGE-GC-01	Charge from Gamma Collision – explains the origin of electric charge.
PAULI-LAYERS-01	Pauli Exclusion from Layers – relates layer capacities to the exclusion principle.
EXP-FINAL-7.8keV	Final 7.8keV Experimental Proposal – detailed design for X-ray resonance search.
EXP-GRAV-01	Gravitational Redshift Anomaly – atomic clock test proposal.
RET-EXT-01	Retraction of Extensions – clarifies that the model applies only to the electron.