Equation of the Universe:

The Coherent Phase Packet (CPP)

Document Class: Foundational

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This document depends on
Equation of the Universe — Core Theory (Rev 3.42.0 or later)

Foundational Definitions

- Coherent Phase Packet (CPP): Fundamental oscillating unit of the EOTU lattice.
- θ is the intra-cycle phase parameter of the King recurrence (not recorded in Constellus).
- speed of light $c = 2.99792458 \times 10^8 \approx 1.667800087 \times 10^{26}\ L_0/\mathrm{s}$
- Z is the **fabric property impedance** $= 376.730313412\ \Omega$
- $\rho_{\mathrm{vac}} \approx 5.36 \times 10^{-10}\ \mathrm{J/m^3}$ empirical vacuum energy density
- Constellus Snapshot Ledger: Record of local CPP state changes at end of each King cycle.
- CMB spectral-distortion limits: $|\varepsilon - 1| \leq 1.7 \times 10^{-5}$ (μ/y era) for the Zero-Phase baseline
- Fine-structure constant stability: $\Delta\alpha/\alpha$ constrained to $\lesssim 10^{-5}$ on cosmological baselines.
- p-p Curvature Coefficient $C_\mu \approx 6.070856966 \times 10^{-41}\ m^3\ \mu^{-1}\ s^{-2} \approx 1.0444933545 \times 10^{13}\ L_0^3\ \mu^{-1} s^{-2}$

For the following values of see main theory **Rev 3.44.0 or later**

- King Wavelength (λ_k)
- Update time ($\tau_0 = \frac{\lambda_k}{c}$)
- Dormant-corridor mean ($\bar{A} = \rho_{vac}\ \lambda_k^3$)
- Phase Tag (Φ_{cpp})

Derived in this document

- Appendix A – The ΔA derivation
- Appendix B – Derivation of ΔA^2

Reference Documents

Ontology Lock

Define the primitive radial quantum: $\boxed{L_0 = 64}$ All halo and core radii are expressed as integer multiples of L_0.

§0 — CPP Geometry – Fundamental Trigonometric

The CPP sinusoid represents the admissible within-King-cycle curvature excursion of a single lattice cell about the dormant mean. Thus, CPP lobes are physically realizable closure states, while CPP waveforms describe the transient deviation path by which closure is reached each cycle. See Figure 1

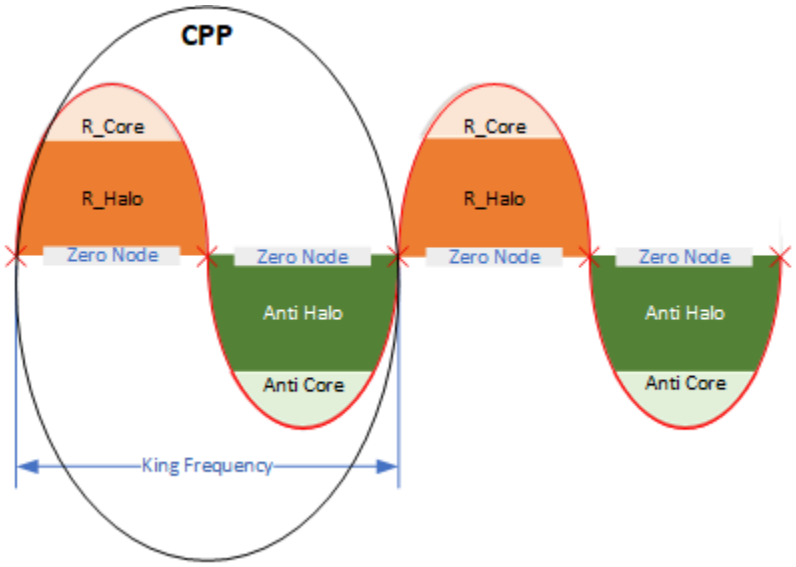

Figure 1-CPP phase diagram ($\Phi_Z = 0$, Zeteon shown)

The 4 Primordial CPPs at eigen States Φ_{cpp} and abundance are:

- **Zeteon** $\phi = 0$, 25%
- **Emeon** $\phi = \frac{\pi}{2}$, 18.75%
- **Uniteon** $\phi = \pi$, 37.50%
- **Deniteon** $\phi = \frac{3\pi}{2}$, 18.75% (phase revised in Version 3.41.17).

Laws (after FO)

- Curvature of a CPP is intrinsic so it cannot be absorbed nor emitted
- Phase of a CPP is intrinsic so it cannot be absorbed nor emitted
- All CPPs have an intrinsic signed phase-channel amplitude q_0, resolved at the King-cycle boundary.

Constellus does not record this intra-cycle deviation; it records only the end-of-cycle changed resolved closure state. At each King-cycle boundary, Constellus records:

1. **Δ - location entries**
2. **Δ - A amplitude entries**

0.1 Phase Coordinate and King Cycle

Define a dimensionless phase coordinate King Frequency:

$$\theta \in [0, 2\pi)$$

Therefore θ represent the phase value within a King cycle. All CPP geometry is expressed as a phase offset Φ_{cpp} to θ.

0.2 Core–Halo Decomposition

Introduce a **dimensionless core threshold**:

$$0 < \sigma < 1$$

The CPP envelope is decomposed as:

- **Core (baryonic):** $| \Delta\mu | \geq \sigma A_Z$
- **Halo (dark matter):** $0 < | \Delta\mu | < \sigma A_Z$

This separation is purely geometric.

0.3 Baryonic / Dark-Matter Ratio Lock

The **best-fit cosmology baryon fraction.** Using Planck 2018 base-ΛCDM values ($\Omega_b h^2 \approx 0.0224$, $\Omega_c h^2 \approx 0.120$), the baryon fraction of total matter is

$$f_b = \frac{\Omega_b}{\Omega_b + \Omega_c} \approx \frac{0.0224}{0.0224 + 0.120} \approx 0.157 \approx \frac{8}{51} = 0.1568627$$

$$r_C = \frac{8}{51}\, r_H$$

Using the locked geometric based on the measured value ratio Baryonic (Core)/Dark Matter (Halo).

$$\rho \equiv \frac{r_{\text{core}}}{r_{\text{halo}}} = 1 - \frac{2}{\pi}\arcsin(\sigma)$$

Setting $\rho = \frac{8}{51} = 0.1568627$. Then:

$$\arcsin(\sigma) = \frac{1-\rho}{2}\pi = \frac{1 - \frac{8}{51}}{2}\pi = \frac{43}{102}\pi$$

So :

$$\boxed{\arcsin(\sigma) = \frac{43\pi}{102}} \Rightarrow \boxed{\sigma = \sin\left(\frac{43\pi}{102}\right) \approx 0.9697969360}$$

The geometric value $\rho = 8/51 = 0.1568627$differs from the empirical baryon fraction approximation 0.157by approximately 0.087%.

0.4 Envelope Radius Mapping Halo

Define the primitive radial quantum:$\boxed{L_0 = 64}$ All halo and core radii are expressed as integer multiples of $r = L_0$.

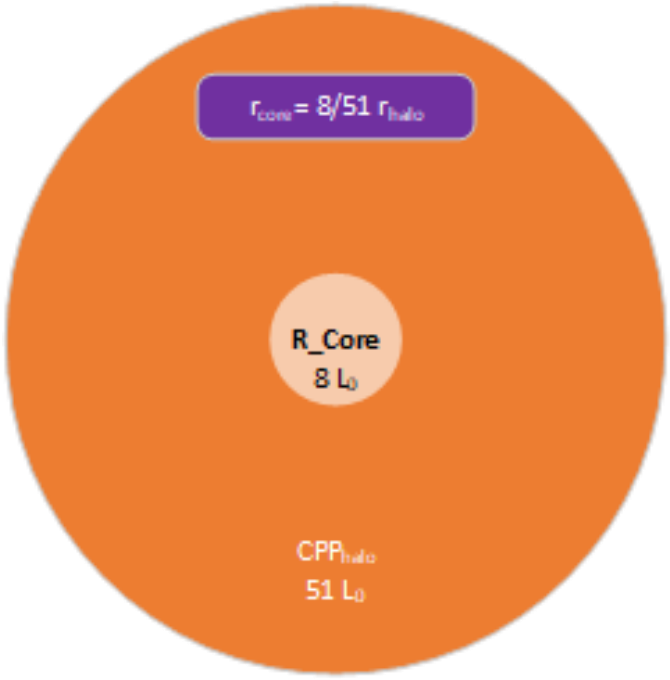

Figure 2-CPP Curvature diagram

So if your **core radius is** $8r$, then the halo radius would be 51r $r_H = \frac{51}{8} \times 8r = 51r$, Distance from center = 51r.

- Halo Area of a CPP: $A_{cpp} = \pi r^2 = \pi(51)^2 = 518{,}171.2825\, r^2$
- Halo Volume of CPP: $V_{CPP} = \frac{4}{3}\pi r^3 = \frac{4}{3}\pi(51)^3 = \frac{4}{3}\pi(132{,}651) \approx 555{,}647.2095\, r^3$

0.5 CPP mass and Energy

See the relevant energy-closure derivation in the core theory document.

$$E_{\text{CPP,3D}}(k) = \frac{2}{3}\pi(51\, L_0)^3\, k^3 \text{ eV}$$

With $L_0 = 64,\ k = 1$:

$$\boxed{E_{\text{CPP,3D}}(k) = 72.834\, k^3 \text{ GeV}}$$

0.6 Envelope as a function of wave function

Let $H(x)$ be the Heaviside step function. $\Delta A_E = \Delta A_U = \Delta A_D = \Delta A_Z$ = Dormant Corridor Deviation (ΔA)

Matter Halo

$$\mu_{+Halo}(\theta) = \Delta A \sin\ \theta\, H(\sin\ \theta)$$

Matter Core

$$\mu_{+Core}(\theta) = \Delta A \sin\ \theta\, H(\sin\ \theta - \sigma)$$

Anti Halo

$$\mu_{-\mathrm{Halo}}(\theta) = \Delta A \sin\ \theta\, H(-\sin\ \theta)$$

Anti Core

$$\mu_{-\mathrm{Core}}(\theta) = \Delta A \sin\ \theta\, H(-\sin\ \theta - \sigma)$$

0.7 Angular Boundaries

Define the boundary angle:

$$\alpha \equiv \arcsin(\sigma)$$

Positive Lobe (Matter)

- Halo: $\theta \in (0, \pi)$
- Core: $\theta \in [\alpha, \pi - \alpha]$

Negative Lobe (Anti / Negative Node Component)

- Halo: $\theta \in (\pi, 2\pi)$
- Core: $\theta \in [\pi + \alpha, 2\pi - \alpha]$

0.8 Derivation of lattice shell units

Consider a closed source emitting a fixed deviation "disturbance inventory" per cycle, call it Q. The shell-scaling result depends on whether W is treated as an amplitude measure or an inventory/intensity measure.

$$\#(N) \propto 4\pi(N\lambda_k)^2 \ \Rightarrow\ \#(N) \propto N^2$$

The **intensity per cell** therefore scales like:

$$I(N) \propto \frac{Q}{N^2}$$

Amplitude is proportional to the square root of intensity (same as the sheet case):

$$A(N) \propto \sqrt{I(N)} \propto \frac{\sqrt{Q}}{N}$$

So:

$$\boxed{A(N) \propto \frac{1}{N}} \Rightarrow \boxed{A(r) \propto \frac{1}{r}}$$

If the inventory Q is proportional to CPP count n (a separate EOTU assumption about source strength), then:

- intensity scales with n
- amplitude scales with $\sqrt{n}$

So strictly:

$$A(r) \propto \frac{\sqrt{n}}{r}$$

not n/r, unless you define "amplitude" as an inventory density rather than a wave displacement.

0.9 Accretion Inequality (Shell Form)

Let two composites with CPP inventories n_A and n_B be separated by shell distance N_{AB}. Using inverse-power envelope influence and Kernel equalization logic:

For symmetric evaluation at the equalization point (or for order-of-magnitude capture bounds), we approximate total overlap inventory as:

$$W_e = \frac{n_A + n_B}{2{N_{AB}}^2}$$

Accretion into receiver configuration occurs iff:

$$\frac{n_A + n_B}{2{N_{AB}}^2} \geq \mu_{\text{recv}}$$

where μ_{recv} is the receiver's curvature remainder defined by the Tier-2 closure partition $\mu + \sin\ \theta = 1$. Solve for N:

$$\boxed{N \leq \sqrt{\frac{n_A + n_B}{2\mu_{\text{recv}}}}}$$

The shell-scaling result depends on whether W is treated as an amplitude measure or an inventory/intensity measure.:

- If W is **amplitude-like** $\rightarrow \sqrt{n}/r$
- If W is **inventory/intensity-like** $\rightarrow n/r^2$

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§1 — Properties of Primordial CPPs

The root of each CPP is its intrinsic phase offset relative to the King cycle. The CPP state is described by a signed sinusoidal deviation about the dormant corridor mean. The signed deviation carries the phase-channel information, while its squared cycle-average carries the curvature-channel inventory.

The intra-cycle phase coordinate is:

$$\theta \in [0,2\pi)$$

Each primordial CPP has a fixed phase offset Φ_{cpp}. The CPP deviation waveform is:

$$\Psi_{cpp}(\theta, \Phi_{cpp}) = \Delta\,\mathrm{Asin}(\theta + \Phi_{cpp})$$

and the absolute CPP amplitude state is:

$$A_{cpp}(\theta) = \bar{A} + \Psi_{cpp}(\theta, \Phi_{cpp})$$

where $\bar{A}$is the dormant corridor mean and $\Delta A$is the maximum deviation magnitude about that mean.

The odd phase channel reverses sign under phase reversal:

$$\Psi(\theta + \pi) = -\Psi(\theta)$$

The quadratic curvature channel remains invariant:

$$\Psi^2(\theta + \pi) = \Psi^2(\theta)$$

Thus the CPP contains two resolved channels:

$$\text{phase channel} = \Psi$$

$$\text{curvature channel} = \Psi^2$$

The phase channel defines signed boundary expression. The curvature channel defines non-negative intrinsic curvature inventory.

1.1 Canonical CPP Amplitude

The primordial CPPs share the same deviation amplitude:

$$\Delta A_E = \Delta A_U = \Delta A_D = \Delta A_Z = \Delta A$$

The adopted lattice-step amplitude is:

$$\Delta A = 2.3456790123 \times 10^{-20}\ \text{eV}$$

This amplitude is native to the CPP deviation scale. It is numerically equal to the King coherence length value expressed through the lattice-step energy normalization:

$$\Delta A = \lambda_k\ \text{eV}$$

The CPP amplitude scale is not an SI electric charge. It is the native EOTU deviation amplitude from which the signed charge source is resolved.

1.2 Intrinsic CPP Curvature

Curvature is the non-negative cycle-averaged inventory of the CPP deviation from the dormant corridor mean. Define:

$$\mu_{cpp} \equiv \langle (A_{cpp}(\theta) - \bar{A})^2 \rangle_K$$

Substituting:

$$A_{cpp}(\theta) - \bar{A} = \Delta\,\mathrm{A}\sin\left(\theta + \Phi_{cpp}\right)$$

gives:

$$\mu_{cpp} = \langle \Delta A^2 \sin^{\,2}(\theta + \Phi_{cpp}) \rangle_K$$

Over one King cycle:

$$\langle \sin^{\,2}(\theta + \Phi_{cpp}) \rangle_K = \frac{1}{2}$$

therefore:

$$\mu_{cpp} = \frac{\Delta A^2}{2}$$

Using:

$$\Delta A = 2.3456790123 \times 10^{-20}\ \mathrm{eV}$$

gives:

$$\Delta A^2 = 5.5022098766 \times 10^{-40}\ \mathrm{eV}^2$$

$$\mu_{cpp} = 2.7511049383 \times 10^{-40}\ \mathrm{eV}^2$$

This curvature inventory is sign-invariant. It does not distinguish positive charge from negative charge.

1.2A Signed Curvature-Deviation Channel

$$\Delta A_{\Phi}(\theta) = \Delta\,\mathrm{A}\sin\left(\theta + \Phi_{cpp}\right)$$

$$q_{cpp}(\theta, \Phi) = q_0 \sin\,(\theta + \Phi_{cpp}), q_0 \equiv \Delta A$$

$$\mu_{cpp} = \langle q_{cpp}^2(\theta, \Phi) \rangle_K = \frac{q_0^2}{2}$$

The native charge channel is the signed curvature-deviation expression of a CPP. The intrinsic CPP curvature inventory μ_{cpp} is the unsigned King-cycle average of the square of that same expression. Thus, native charge and intrinsic curvature inventory are not independent primitives. Charge preserves signed phase orientation, while μ_{cpp} records the corresponding sign-invariant inventory.

1.3 Intrinsic CPP Charge

Charge is the resolved signed projection of CPP curvature-phase asymmetry. It belongs to the odd phase channel, not the even curvature channel.

Define the native CPP charge magnitude as:

$$q_0 \equiv \Delta A$$

so that:

$$q_0 = 2.3456790123 \times 10^{-20}\ \text{eV}$$

The signed CPP charge source is:

$$q_{cpp}(\theta, \Phi_{cpp}) = q_0 \sin(\theta + \Phi_{cpp})$$

The normalized signed charge state is:

$$\hat{q}_{cpp}(\theta, \Phi_{cpp}) = \frac{q_{cpp}(\theta, \Phi_{cpp})}{q_0} = \sin(\theta + \Phi_{cpp})$$

The Emeon and Deniteon define the maximum signed separation because their phase offsets differ by π:

$$\Phi_D - \Phi_E = \pi$$

Their deviations are:

$$\Psi_E(\theta) = \Delta\,\text{Asin}\left(\theta + \frac{\pi}{2}\right) = \Delta\,\text{Acos}\,\theta$$

$$\Psi_D(\theta) = \Delta\,\text{Asin}\left(\theta + \frac{3\pi}{2}\right) = -\Delta\,\text{Acos}\,\theta$$

Therefore:

$$\Psi_D(\theta) = -\Psi_E(\theta)$$

and the maximum signed separation is:

$$|\,\Delta\Psi_{ED}\,|_{max} = 2\Delta A$$

One native charge unit is one half of this maximum signed separation:

$$q_0 = \frac{1}{2}\,|\,\Delta\Psi_{ED}\,|_{max}$$

so:

$$q_0 = \Delta A$$

Charge is therefore the signed boundary expression of CPP phase topology. It is equal in magnitude for positive and negative states because the contributing CPP eigenstates have equal amplitude and are separated by πin phase.

1.4 Resolved Boundary Charge States

At the King-cycle boundary, the four primordial CPPs resolve as:

$$q_Z = q_0 \sin(0) = 0,\ \ q_E = q_0 \sin\left(\frac{\pi}{2}\right) = +q_0,\ \ q_U = q_0 \sin(\pi) = 0,\ \ q_D = q_0 \sin\left(\frac{3\pi}{2}\right) = -q_0$$

Thus:

$$q_Z = 0, \qquad q_E = +q_0, \qquad q_U = 0, \qquad q_D = -q_0$$

The Zeteon and Uniteon are neutral in resolved charge. The Emeon and Deniteon carry equal and opposite signed charge expression.

1.5 Charge-Response Comparison

The native CPP charge magnitude is:

$$q_0 = \Delta A = 2.3456790123 \times 10^{-20}\ \text{eV}$$

For one equal-magnitude charge pair:

$$q_1 q_2 = q_0^2$$

$$q_0^2 = (2.3456790123 \times 10^{-20})^2 = 5.5022098766 \times 10^{-40}\ \text{eV}^2$$

The familiar SI Coulomb one-charge-pair coefficient is:

$$k_e e^2 = \frac{e^2}{4\pi\varepsilon_0}$$

$$k_e e^2 \approx 2.3070775524 \times 10^{-28}\ \text{N m}^2$$

The SI charge-response coefficient required to express the native EOTU charge amplitude in Coulomb-force form is therefore:

$$K_{q,SI} \equiv \frac{k_e e^2}{q_0^2}$$

Substitution gives:

$$K_{q,SI} = \frac{2.3070775524 \times 10^{-28}}{5.5022098766 \times 10^{-40}} \approx 4.1930028 \times 10^{11}\ \frac{\text{N m}^2}{\text{eV}^2}$$

The corresponding force form is:

$$F_q(r) = K_{q,SI} \frac{q_0^2}{r^2}$$

$$F_q(r) = \frac{2.3070775524 \times 10^{-28}\ \mathrm{N\,m^2}}{r^2}$$

which is the Coulomb one-charge-pair form:

$$F_q(r) = \frac{1}{4\pi\varepsilon_0}\frac{e^2}{r^2}$$

This comparison does not redefine $q_0$as Coulombs. It shows how the native CPP charge amplitude maps into the measured SI Coulomb-force response.

1.6 Curvature-Adjacent Phase-Channel Scale

The compact curvature coefficient derived in the curvature document is:

$$C_{\mu,L0}^{pp} = 1.0444933545 \times 10^{13}\ L_0^3\,\mu^{-1}s^{-2}$$

A curvature-adjacent signed phase-channel scale can be formed by applying the two-body angular response factor and the smallest closure-boundary correction:

$$K_{q,\mu} = \frac{C_{\mu,L0}^{pp}}{8\pi}\left(\frac{129}{128}\right)$$

$$K_{q,\mu} = \frac{1.0444933545 \times 10^{13}}{8\pi}\left(\frac{129}{128}\right)$$

$$K_{q,\mu} \approx 4.1883750334 \times 10^{11}$$

$K_{q,\mu}$ is used here as a native numerical scale for comparison with $K_{q,SI}$; SI force units are not assigned to $K_{q,\mu}$. The SI Coulomb-response bridge from Section 1.5 is:

$$K_{q,SI} \approx 4.1930028 \times 10^{11}\,\frac{\mathrm{N\,m^2}}{\mathrm{eV^2}}$$

The numerical difference is:

$$\frac{K_{q,\mu} - K_{q,SI}}{K_{q,SI}} \times 100 \approx -0.11034\%$$

This comparison shows that the curvature-adjacent signed phase-channel scale lies within approximately 0.11034%of the measured SI Coulomb-response bridge. The comparison is numerical. The SI units enter through the Coulomb-response bridge defined in Section 1.5, not through direct unit conversion from $C_{\mu,L0}^{pp}$.

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§2 — Curvature and Phase Descriptors

2.1 Intrinsic CPP Phase Descriptor $\boldsymbol{\mathcal{P}_{\Phi}(\theta)}$

$$\mathcal{P}_{\Phi}(\theta, \Phi) = q_0 \sin\left(\theta + \Phi_{cpp}\right)$$

The CPP phase descriptor represents intrinsic charge inventory (source). The spatial electric field is the fabric response governed by a divergence (Gauss) law and is not part of the intrinsic CPP descriptor.

2.2 Intrinsic CPP Curvature Descriptor $\boldsymbol{\mathcal{C}_{\Phi}(\theta)}$

$$\boldsymbol{\mathcal{C}}_{\Phi}(\theta, \Phi) = \frac{\Delta A^2}{2}$$

Appendix A – The ΔA derivation

ΔA is defined as the 1-lattice energy step: $\Delta A \equiv e\,E\,\lambda_k$ with $E = 1\ \mathrm{V/m} \Rightarrow \Delta A = \lambda_k\ \mathrm{eV}$.

A.1 CPP deviation waveform (baseline + deviation)

$$A_{\mathrm{cpp}}(t) = \bar{A} + \Delta A \sin(\omega_0 t + \Phi_{\mathrm{cpp}})$$

- Ā: dormant corridor mean (absolute baseline)
- ΔA: maximum deviation magnitude relative to Ā

A.2 Curvature inventory (cycle-average of squared deviation)

Your CPP document defines intrinsic curvature as:

$$\mu_{\mathrm{cpp}} \equiv \langle (A_{\mathrm{cpp}}(t) - \bar{A})^2 \rangle_K$$

Substitute $A_{\mathrm{cpp}} - \bar{A} = \Delta A \sin(\cdot)$, then over a full cycle:

$$\boxed{\mu_{\mathrm{cpp}} = \frac{\Delta A^2}{2}}$$

This is shown explicitly in Appendix B.

A.3 Rule (Normalization / lattice-step energy):

Adopt the lattice-step energy as the CPP deviation amplitude scale:

$$\boxed{\Delta A \equiv \Delta E_{\mathrm{lattice}}}$$

Using Appendix C:

$$\Delta E_{\mathrm{lattice}} = e\,E\,\lambda_k$$

Using the normalization choice $E = 1\ \mathrm{V/m}$:

$$\Delta A = e\,(1\ \mathrm{V/m})\,\lambda_k$$

Now use the identity $e \times 1\mathrm{V} = 1\ \mathrm{eV}$:

$$\boxed{\Delta A = \lambda_k\ \mathrm{eV}}$$

So **numerically**, ΔA is the same number as λ_k, but expressed in **eV** (not meters). It is a direct consequence of that lattice-step normalization. Now convert to Joules:

$$1\ \mathrm{eV} = 1.602176634 \times 10^{-19}\ \mathrm{J}$$

$$\boxed{\Delta A = 2.3456790123 \times 10^{-20}\ \mathrm{eV} = 3.757466739 \times 10^{-39}\ \mathrm{J}}$$

Appendix B – Derivation of ΔA^2

let

$$x = \omega_0 t + \Phi_{\text{cpp}}$$

Then:

$$dx = \omega_0 dt \Rightarrow dt = \frac{dx}{\omega_0}$$

Over one King cycle:

$$t = 0 \Rightarrow x = \Phi_{\text{cpp}}$$

$$t = T_0 = \frac{2\pi}{\omega_0} \Rightarrow x = \Phi_{\text{cpp}} + 2\pi$$

So the integral becomes:

$$\mu_{\text{cpp}} = \frac{1}{T_0} \int_{\Phi_{\text{cpp}}}^{\Phi_{\text{cpp}}+2\pi} \Delta A^2 \sin^2(x) \frac{dx}{\omega_0}$$

Since $T_0 = 2\pi/\omega_0$, the constants cancel cleanly:

$$\mu_{\text{cpp}} = \frac{\omega_0}{2\pi} \cdot \frac{1}{\omega_0} \int_{\Phi_{\text{cpp}}}^{\Phi_{\text{cpp}}+2\pi} \Delta A^2 \sin^2(x)\, dx$$

$$= \frac{1}{2\pi} \int_{\Phi_{\text{cpp}}}^{\Phi_{\text{cpp}}+2\pi} \Delta A^2 \sin^2(x)\, dx$$

Now here is the important fact:

$$\int_{\Phi}^{\Phi+2\pi} \sin^2(x)\, dx = \int_0^{2\pi} \sin^2(x)\, dx = \pi$$

Curvature Result

$$\mu_{cpp} = \langle (A_{cpp} - \bar{A})^2 \rangle = \frac{\Delta A^2}{2}$$

In $(\text{eV})^2$

$$\Delta A^2 = (2.3456790123 \times 10^{-20}\ \text{eV})^2 = 5.5022098766 \times 10^{-40}\ (\text{eV})^2$$

$$\boxed{\mu_{cpp} = \frac{\Delta A^2}{2} = 2.7511049383 \times 10^{-40}\ (\text{eV})^2 = 7.06394 \times 10^{-78}\ \text{J}^2}$$

Appendix C - Derive $E = 1\ \mathrm{V/m}$

C.1 Electric Field as a Discrete Gradient

By definition, the electric field is the spatial gradient of potential:

$$E \equiv \frac{\Delta V}{\Delta x}$$

Across a single lattice:

$$E = \frac{\Delta V_{\text{lattice}}}{\lambda_k}$$

Therefore,

$$\boxed{\Delta V_{\text{lattice}} = E\,\lambda_k}$$

This is the discrete lattice form of the macroscopic electric field.

C.2 Energy Transfer per lattice

For a charge e, the energy change across one lattice is:

$$\Delta E_{\text{lattice}} = e\ \Delta V_{\text{lattice}}$$

Substituting from B.1:

$$\boxed{\Delta E_{\text{lattice}} = e\,E\,\lambda_k}$$

This is the general lattice energy-gradient relation. No specific field magnitude is assumed.

C.3 Normalization Case

If one chooses the specific lattice energy step

$$\Delta E_{\text{lattice}} = e\,\lambda_k$$

then from B.2:

$$e\,E\,\lambda_k = e\,\lambda_k$$

which implies

$$\boxed{E = 1\ \mathrm{V/m}}$$

This normalization is adopted in EOTU to set the lattice-step energy scale (used to define ΔA).

Appendix D - Stability Principles

§0 — Purpose

Evaluate whether CPP archetypes at phases of the form $\Delta\varphi = \pi/n$ with odd n ($n \in \{3,5,7,9,11\}$) can exist as stable eigen-states. This corrects the prior survey by excluding composite angles (e.g., $5\pi/6$) and restricting to true π/odd-n cases.

§1 — Stability Principles

• S1 — Orthogonality: Stable CPP eigen-archetypes occur only at quarter-turns $\Delta\varphi = k\cdot\pi/2$.
• S2 — Decomposition: Any other phase decomposes into the orthogonal basis {Zero-Phase, Quarter-Phase} and cannot maintain independent coherence.
• S3 — Observational Veto: A stable non-canonical phase would produce measurable departures (CMB μ/y, α-stability, ΔN_eff, baryon mass hierarchy), none of which are observed.

$$\sin(\omega t - \delta) = \sin \omega t \cdot \cos \delta - \cos \omega t \cdot \sin \delta$$

§2 — Survey: Δϕ = π/n with odd n

n (odd)	Δφ (deg)	Projection on Zero (cos δ)	Projection on Quarter (sin δ)	Nearest Attractor	Verdict
3	60.0°	0.500	0.866	Quarter-Phase (Δφ=π/2)	Not stable; decomposes and relaxes to canonical basis
5	36.0°	0.809	0.588	Zero-Phase (Δφ=0)	Not stable; decomposes and relaxes to canonical basis
7	25.714°	0.901	0.434	Zero-Phase (Δφ=0)	Not stable; decomposes and relaxes to canonical basis
9	20.0°	0.940	0.342	Zero-Phase (Δφ=0)	Not stable; decomposes and relaxes to canonical basis
11	16.364°	0.959	0.282	Zero-Phase (Δφ=0)	Not stable; decomposes and relaxes to canonical basis

§3 — Observational Veto Anchors (for context)

• CMB spectral-distortion limits: $|\varepsilon-1| \le 1.7\times10^{-5}$ (μ/y era) for the Zero-Phase baseline.
• Fine-structure constant stability: $\Delta\alpha/\alpha$ constrained to $\lesssim 10^{-5}$ on cosmological baselines.

• Effective relativistic species: $\Delta N_{eff} \lesssim 0.3$ at recombination.
Any persistent π/odd-n state would violate at least one of these bounds; none do.

§4 — Result and Corollary

For all odd n tested (3,5,7,9,11), $\Delta\varphi = \pi/n$ states resolve into the orthogonal quarter-turn basis with projection weights (cos δ, sin δ). Because no independent eigen-coherence is sustained and no observational signatures are present, these phases are non-canonical.

$$\text{Stable archetypes remain: } \Delta\varphi \in \{ 0, \pi/2, \pi, 3\pi/2 \} \qquad \text{(Eq OD′-C1)}$$

§5 — Box OD'-NC — Negative Corollary (π/odd-n)

If a π/odd-n archetype were stable, it would appear as an independent coherence channel with distinct observational signatures. Since none are observed and the decomposition (Eq OD′-1.1) forces relaxation to the nearest quarter-turn attractor, no π/odd-n archetype constitutes a fifth state; the canonical four exhaust the stable set.

Appendix F – Field Derivation in discrete lattice

1) Discrete field placement on the lattice

Assume a cubic lattice with spacing λ_k. Let lattice nodes be indexed by integer triples $n = (n_x, n_y, n_z)$with physical position $\vec{r}_n = \lambda_k\, n$.

Define the EOTU electric-like field on **links** (edges) as components along the coordinate axes:

$$\mathcal{E}_x\left(n+\frac{1}{2}\hat{x}\right), \mathcal{E}_y\left(n+\frac{1}{2}\hat{y}\right), \mathcal{E}_z\left(n+\frac{1}{2}\hat{z}\right)$$

This is the natural discrete analogue of a continuous vector field: one value per oriented link.

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2) Discrete divergence (the lattice Gauss operator)

Define the divergence at a node $n$as "net outward flux per cell volume":

$$\boxed{(\nabla_d \cdot \vec{\mathcal{E}})(n) = \frac{1}{\lambda_k}[\mathcal{E}_x(n+\frac{1}{2}\hat{x}) - \mathcal{E}_x(n-\frac{1}{2}\hat{x}) + \mathcal{E}_y(n+\frac{1}{2}\hat{y}) - \mathcal{E}_y(n-\frac{1}{2}\hat{y}) + \mathcal{E}_z(n+\frac{1}{2}\hat{z}) - \mathcal{E}_z(n-\frac{1}{2}\hat{z})]}$$

This is a standard finite-difference divergence (a flux balance). It is the discrete object whose continuum limit is $\nabla \cdot \vec{\mathcal{E}}$.

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3) CPP phase as the source term on the lattice

For a single CPP at node n_0, your intrinsic source inventory is:

$$q_{cpp}(\theta) = q_0 \sin(\theta + \Phi_{cpp})$$

Convert this to a **lattice charge density** (charge per cell volume) using the Kronecker delta:

$$\boxed{\rho_q(n,\theta) = \frac{q_{\text{cpp}}(\theta)}{\lambda_k^3}\,\delta_{n,n_0}}$$

For a Region of CPPs, it's just a sum of such sources.

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4) Discrete Gauss law (EOTU fabric divergence law)

Postulate the lattice Gauss law:

$$\boxed{(\nabla_d \cdot \vec{\mathcal{E}})(n,\theta) = \frac{\rho_q(n,\theta)}{\varepsilon_f}}$$

This is the EOTU statement that **charge inventory is the source of divergence of the fabric response field**.

Discrete global conservation (automatic)

Sum both sides over all nodes in a finite volume V. The divergence sum becomes a boundary flux (telescopes), giving the discrete version of Gauss's theorem:

$$\boxed{\sum_{n\in V}(\nabla_d\cdot\vec{\mathcal{E}})(n)\,\lambda_k^3=\sum_{f\in\partial V}\mathcal{E}_f\;A_f=\frac{Q_{\text{enc}}}{\varepsilon_f}}$$

This is the exact lattice statement of "charge does not vary": **total flux is locked to enclosed inventory**.

5) Introduce a lattice potential and get discrete Poisson

Define a scalar potential $\varphi(n,\theta)$at nodes, and define the link field as a discrete gradient:

$$\boxed{\mathcal{E}_x(n+\frac{1}{2}\hat{x})=-\frac{\varphi(n+\hat{x})-\varphi(n)}{\lambda_k}}$$

(and similarly for y,z).

Then substituting into the divergence gives discrete Poisson:

$$\boxed{-(\Delta_d\varphi)(n)=\frac{\rho_q(n)}{\varepsilon_f}}$$

with the **discrete Laplacian**:

$$\boxed{(\Delta_d\varphi)(n)=\frac{1}{\lambda_k^2}[\varphi(n+\hat{x})+\varphi(n-\hat{x})+\varphi(n+\hat{y})+\varphi(n-\hat{y})+\varphi(n+\hat{z})+\varphi(n-\hat{z})-6\varphi(n)]}$$

This is the canonical discrete Laplacian used in lattice Green function theory.

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6) Lattice Green function solution (the "Coulomb law" emerges)

Define the lattice Green function $G(n)$as the solution to:

$$\boxed{-\Delta_d G(n)=\frac{1}{\lambda_k^3}\delta_{n,0}}$$

Then for a single CPP source at n_0:

$$\boxed{\varphi(n)=\frac{q_{\text{cpp}}}{\varepsilon_f}\,G(n-n_0)}$$

and the field is the discrete gradient of φ.

Far-field behavior (continuum recovery)

A key result from lattice Green function theory is that in 3D the massless lattice Green function recovers Euclidean isotropy at long distances and behaves like the continuum $1/r$Green function with controlled corrections.

In practical terms:

$$\boxed{G(n) \sim \frac{1}{4\pi \mid \vec{r}_n \mid} \text{for } \mid \vec{r}_n \mid \gg \lambda_k}$$

so:

$$\boxed{\mid \vec{\mathcal{E}}(\vec{r}) \mid \sim \frac{1}{4\pi\varepsilon_f}\frac{q_{\text{cpp}}}{r^2}(r \gg \lambda_k)}$$

That's your inverse-square law — **derived as the continuum limit** of the lattice divergence rule, not inserted into the CPP descriptor.

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7) What EOTU gets "for free" below λ_k

This discrete formulation immediately gives you three EOTU-native consequences:

(A) No true $r \to 0$singularity

There is no "arbitrarily small sphere." The smallest meaningful neighborhood is one lattice cell. The discrete Green function is well-defined on the lattice; the continuum divergence at a point is replaced by a Kronecker delta at a node.

(B) Near-field anisotropy

For $r$only a few lattice steps, solutions depend on direction (axis vs diagonal) because the lattice is not rotationally invariant at short range. Isotropy is recovered only asymptotically.

(C) Maxwell as an emergent large-scale rule

At $r \gg \lambda_k$, the discrete operators converge to the continuum operators, so Maxwell-like fields emerge automatically.

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8) Bridge constant in your preferred form (Z, c)

Once you identify this response mode with the measured EM mode, you can connect:

$$\varepsilon_f = \frac{1}{Zc}$$

so the far-field becomes:

$$\boxed{|\,\vec{\mathcal{E}}(r)\,| \sim \frac{Zc}{4\pi}\frac{q_{\mathrm{cpp}}}{r^2}}$$

(with the same caveat: this is the **continuum limit** $r \gg \lambda_k$).