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NUVO Quantization I: Scalar Coherence and the Quantum of Action

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Abstract

This paper demonstrates that quantization arises naturally in NUVO space from the geometric coherence of the scalar field λ, without invoking probabilistic or wave—mechanical postulates. By enforcing closure of the scalar—weighted arc element on the conformal manifold (M, g) with $g = \lambda^2 \eta$, discrete action levels are obtained. The coherence condition leads to a universal action constant, empirically identified with $\hbar$ when calibrated to the ground—state energy of hydrogen. This result establishes quantization as a geometric property of NUVO space itself, forming the bridge between scalar conformal geometry and microscopic physical structure.

Keywords

NUVO Space, Scalar Field, Conformal Geometry, Quantization, Geometric Phase, Scalar Coherence

1. Introduction

The NUVO space framework defines a conformally flat geometry in which the metric tensor

$$g_{\mu\nu} = \lambda^2(x)\eta_{\mu\nu},\ \lambda > 0,$$

is generated by a positive scalar field λ acting upon a flat background metric $\eta_{\mu\nu}$. This metric form is adopted because it is the unique conformal deformation that preserves local angles and null structure while allowing all curvature, measure, and connection properties to be encoded in a single scalar function $\lambda(x)$. It thus provides the minimal scalar extension of flat geometry capable of generating quantized holonomy without introducing additional tensor degrees of freedom.

Previous studies [1] [2] established the differential and variational structure of this geometry, showing that all geometric measures and operators scale in fixed powers of λ and that the Levi-Civita connection is uniquely determined by λ alone. Within this self-contained framework, no additional tensor degrees of freedom are required to describe curvature or dynamics. Conformal approaches of this kind have been explored in various gravitational contexts [3] [4], but the present formulation differs by imposing a unit-constrained frame that uniquely determines the scalar field λ and its geometric coherence. Unlike Weyl's original gauge geometry, which introduced an independent vector connection to restore scale invariance, the NUVO framework employs a single scalar field λ whose logarithmic gradient acts as the geometric connection itself. This approach distinguishes NUVO from conformal field theories or scalar-tensor models by assigning the entire conformal modulation to one measurable scalar degree of freedom rather than to a composite gauge field.

The term *NUVO* is not an acronym but a name introduced by the author to denote a conformally flat scalar geometry governed by a single field $\lambda(x)$. It serves as a concise label for the theoretical framework developed in this and subsequent papers, rather than an abbreviation of other words.

The present paper addresses a fundamental question that follows naturally from those results: *can the continuous scalar geometry of NUVO space give rise to discrete*, *quantized configurations without the introduction of external quantization postulates*? In ordinary field theory discreteness enters by assumption, through operator quantization or boundary conditions applied to wave equations. Here it will be shown that in NUVO space the same property emerges from a purely geometric requirement of *scalar coherence* that transport of the unit-constrained frame around a closed trajectory return to its initial state.

This closure requirement yields a topological condition on the scalar field λ, expressed as an integer multiple of a universal action constant. The resulting coherence condition introduces a universal action constant that may be empirically calibrated in physical systems (Section 5). Its numerical value will later be shown to correspond to the known quantum of action. Quantization therefore arises in NUVO space as a consequence of the conformal structure itself. Subsequent sections derive this result from first principles, introduce the coherence integral, and illustrate its implications using a Coulombic scalar field as a concrete example.

2. Scalar Arc Geometry

Let γ denote a differentiable curve on the conformal manifold (M,g) with background metric $\eta_{\mu\nu}$. The conformal relation $g_{\mu\nu}=\lambda^2\eta_{\mu\nu}$ implies that the physical line element measured in g is related to that in η by

$$\mathrm{d}\ell_{\lambda}=\sqrt{g_{\mu\nu}\mathrm{d}x^{\mu}\mathrm{d}x^{\nu}}=\lambda\sqrt{\eta_{\mu\nu}\mathrm{d}x^{\mu}\mathrm{d}x^{\nu}}=\lambda\mathrm{d}\ell_{\eta}. \tag{1}$$

The scalar field $\lambda(x)$ therefore acts as a local scaling of length, time, and all derived geometric measures. A spatial or temporal variation in λ alters the effective distance experienced along the same coordinate path.

For a closed trajectory γ the total arc length measured in the conformal metric is

$$L_\lambda = \oint_\gamma \mathrm{d}\ell_\lambda = \oint_\gamma \lambda \mathrm{d}\ell_\eta. \tag{2}$$

The difference between this and the background length $L_\eta = \oint_\gamma \mathrm{d}\ell_\eta$ quantifies the net modulation imposed by the scalar field. Define this *scalar excess arc* as

$$\Delta s = \oint_\gamma (\lambda - 1) \mathrm{d}\ell_\eta, \tag{3}$$

which represents the cumulative advance (or retardation) of the scalar frame as it traverses one closed circuit.

Equation (3) has a direct geometric interpretation: if $\lambda > 1$ along a segment of the path, the scalar field locally expands the measure of length, producing an excess arc; if $\lambda < 1$, it contracts the measure and the excess becomes negative. When λ varies continuously, Δs may take any real value, and no discreteness appears. Quantization requires the additional constraint that the conformal frame after one complete traversal of γ be indistinguishable from its initial state—a *coherence condition* to be developed in the next section.

It is this requirement of unit return, applied to (3), that discretizes the otherwise continuous family of λ-configurations. Hence, the scalar excess arc Δs plays the same role in NUVO space as the classical action does in conventional mechanics: it is the geometric quantity whose closure enforces quantization.

3. Canonical One-Form and Coherence Condition

The geometric relation (2) suggests that the conformal line element can be regarded as the integral of a differential one-form over the trajectory γ. Define the *canonical one-form* associated with the scalar field as

$$\theta = \lambda \mathrm{d}\ell_\eta. \tag{4}$$

This one-form encodes the infinitesimal scalar advance of the conformal frame relative to the background metric. Its integral along a path gives the total scalar arc:

$$\oint_\gamma \theta = \oint_\gamma \lambda \mathrm{d}\ell_\eta = L_\lambda. \tag{5}$$

3.1. Coherence of the Unit-Constrained Frame

In the unit-constrained formulation of NUVO space, each observer carries a local frame whose scalar unit is fixed by the value of $\lambda(x)$. Transporting this frame around a closed curve may, in general, return it with a different relative phase if λ varies along the path. The physical requirement that the transported unit coincide with its original value after one complete circuit defines the condition of *scalar coherence*.

This closure requirement imposes a topological constraint on the integral (5). Because the phase of the scalar unit can be represented by an angle variable φ whose differential satisfies $\mathrm{d}\varphi \propto \theta / \mathcal{A}$, the condition that the unit return to its initial state demands

$$\oint_\gamma \theta = 2\pi n\mathcal{A},\ \ n\in\mathbb{Z}, \tag{6}$$

where $\mathcal{A}$ is a universal constant with dimensions of action. Equation (6) is the *scalar coherence condition* and constitutes the quantization rule for closed paths on NUVO space. Geometrically, this condition states that a scalar-unit frame, when parallel-transported once around a closed trajectory, must return to its original state. The integral of the scalar connection θ thus measures the holonomy of the local scale field, and coherence requires that this holonomy be an integer multiple of a universal constant. A formal derivation of this interpretation is given in Appendix A, where the scalar connection and its holonomy group are constructed explicitly.

3.2. Gauge Invariance

The coherence condition is invariant under the global rescaling

$$(\eta_{\mu\nu},\lambda)\mapsto(\alpha^2\eta_{\mu\nu},\lambda/\alpha),\alpha>0,$$

since $g_{\mu\nu}=\lambda^2\eta_{\mu\nu}$ and the product $\lambda\mathrm{d}\ell_\eta$ remain unchanged. Hence the integral (6) depends only on the intrinsic geometry of (M,g) and not on the chosen normalization of λ or η. This ensures that quantization in NUVO space is a geometric invariant rather than a coordinate artifact.

3.3. Interpretation

Equation (6) expresses the discrete holonomy of the scalar field: the scalar length element θ accumulates in integer multiples of a fundamental action constant as the conformal frame completes each closed circuit. The universal constant $\mathcal{A}$ sets the fundamental scale of scalar coherence in NUVO space. Its empirical calibration, discussed in Section 5, reveals its correspondence with the quantum of action.

4. Scalar Action Functional and Discrete Solutions

The coherence condition (6) can be expressed as a stationary principle for the scalar arc functional associated with the field λ. For a path γ on (M,g) define the *scalar action functional*

$$S[\gamma]=\int_\gamma \lambda\mathrm{d}\ell_\eta, \tag{7}$$

whose extremal value represents the geometrically consistent trajectory of the scalar frame. Variation of (7) with respect to the coordinates $x^\mu(t)$ at fixed endpoints gives

$$\delta S=\int_\gamma \frac{\partial\lambda}{\partial x^\mu}\delta x^\mu\mathrm{d}\ell_\eta+\int_\gamma\lambda\delta(\mathrm{d}\ell_\eta)=0. \tag{8}$$

Using the standard relation

$$\delta(\mathrm{d}\ell_\eta)=\frac{u_\mu\mathrm{d}(\delta x^\mu)}{\mathrm{d}\ell_\eta},\ \ u^\mu=\frac{\mathrm{d}x^\mu}{\mathrm{d}\ell_\eta},$$

and integrating by parts, one obtains the stationary condition

$$\nabla_\eta \lambda \cdot u = 0 \text{ along } \gamma, \tag{9}$$

which states that λ is constant along the tangent direction of an extremal curve. Hence, coherent trajectories correspond to paths whose tangent vectors lie everywhere in the level surfaces of λ.

4.1. Discrete Solutions

Combining the stationary condition (9) with the closure rule (6) restricts the admissible configurations of λ. Only those scalar fields for which the integral of $\lambda \mathrm{d}\ell_\eta$ over a closed orbit equals $2\pi n\mathcal{A}$ satisfy both conditions simultaneously. The set of such configurations forms a discrete family $\{\lambda_n\}$, each corresponding to a distinct coherent state of the scalar field.

In the limit of slowly varying λ the extremal condition (9) reduces to $\nabla_\eta \lambda \approx 0$ within the orbit, so the discrete sequence λ_n approaches equally spaced values in λ-space. The difference between successive levels is determined by the action increment

$$\Delta S = 2\pi\mathcal{A}. \tag{10}$$

Equation (10) plays the role of the elementary quantum of action in NUVO space, arising not from operator postulates but from geometric coherence of the scalar field.

4.2. Boundary Conditions

The discrete solutions λ_n are defined under the boundary condition

$$\lambda \to 1 \text{ as } r \to \infty,$$

ensuring that the conformal metric asymptotically approaches the background metric η. This requirement fixes the zero of the scalar field and provides a unique normalization for the sequence of coherent states.

The family $\{\lambda_n\}$ therefore represents globally coherent, self-consistent scalar configurations on NUVO space. Their existence establishes that quantization emerges naturally from the geometric closure and variational structure of the scalar field, without recourse to additional physical assumptions.

5. Example: Relativistic Modulation and the $2\pi r_e$ Advance

NUVO admits only gravitational potential as a geometric modulator; electromagnetic forces enter *only* through kinematics (to relate v and r). For a particle of rest energy $E_0 = m_e c^2$ the special-relativistic kinetic energy is

$$T_{\mathrm{SR}} = (\gamma - 1)E_0, \quad \gamma = \frac{1}{\sqrt{1 - v^2/c^2}}. \tag{11}$$

Hence

$$1 + \frac{T_{\mathrm{SR}}}{E_0} = 1 + (\gamma - 1) = \gamma. \tag{12}$$

With gravitational potential entering in dimensionless form $\Phi_g(r) := \frac{GM}{rc^2}$ (and negligible for atomic scales), the NUVO scalar is

$$\lambda(r,v) = \gamma(v) + \Phi_g(r) \approx \gamma(v). \tag{13}$$

The relativistic form $\lambda = \gamma + \Phi_g$ parallels the Lorentz dilation structure used in classical field theory [5] [6], but here the modulation enters as a conformal scaling factor in the metric rather than as a dynamical time variable.

5.1. Carry λ^2 in the Metric (Worldline Form)

The conformal metric is $g_{\mu\nu} = \lambda^2 \eta_{\mu\nu}$, so the spatial proper element on a circular orbit of radius r scales by λ^2:

$$d\ell_\lambda = \sqrt{g_{ij}dx^i dx^j} = \lambda d\ell_\eta \;\Rightarrow\; L_\lambda = \oint d\ell_\lambda = \lambda(2\pi r). \tag{14}$$

Equivalently, one may regard the *proper radius* as

$$r_{\text{mod}} = \lambda^2 r. \tag{15}$$

Using (13) and neglecting Φ_g at atomic scales,

$$\lambda^2 \approx \gamma^2 = \frac{1}{1 - v^2/c^2}. \tag{16}$$

5.2. Eliminate v by Coulomb Kinematics (No EM in λ)

For a circular Coulomb orbit (kinematics only),

$$\frac{m_e v^2}{r} = \frac{e^2}{4\pi\varepsilon_0 r^2} \;\Rightarrow\; \frac{v^2}{c^2} = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}\frac{1}{r} = \frac{r_e}{r},\; r_e := \frac{e^2}{4\pi\varepsilon_0 m_e c^2}. \tag{17}$$

Insert (17) into (16):

$$\lambda^2(r) = \frac{1}{1 - r_e/r} = 1 + \frac{r_e}{r} + O\left(\frac{r_e^2}{r^2}\right),\; \frac{r_e}{r} \ll 1. \tag{18}$$

Therefore the proper radius is shifted by a *constant* amount

$$r_{\text{mod}} = \lambda^2 r \approx r + r_e, \tag{19}$$

independent of r to first order.

5.3. Universal Arc Advance, Fine Structure Constant, and Action

Because the orbital phase is 2π, the scalar-modulated arc-length advance per orbit is

$$\boxed{\Delta s = 2\pi r_e}, \tag{20}$$

independent of the orbital radius. Here $r_e = \frac{e^2}{4\pi\varepsilon_0 m_e c^2}$ is the classical electron radius, and the constant per-orbit advance Δs is a purely geometric property of the relativistic scalar modulation (Section 5).

Coherence and derivation of α from empirical data. Empirical ground-state energy for hydrogen is $|E_1| = 13.6\ \text{eV}$. From circular-orbit mechanics (used only as kinematics),

$$|E_1| = \frac{e^2}{8\pi\varepsilon_0 a_0} \Rightarrow a_0 = \frac{e^2}{8\pi\varepsilon_0 |E_1|}, \tag{21}$$

which defines the Bohr radius a_0 directly from the measured energy, without reference to $\hbar$. NUVO coherence requires that the accumulated scalar advance over all closed orbits equals the background circumference:

$$N_* \Delta s = 2\pi a_0.$$

Substituting $\Delta s = 2\pi r_e$ gives

$$N_* = \frac{a_0}{r_e},$$

but by definition of the fine structure constant in the NUVO coherence rule, $N_* = 1/\alpha^2$. Hence

$$\boxed{\alpha^2 = \frac{r_e}{a_0}}. \tag{22}$$

Eliminating a_0 and r_e via their definitions yields

$$\alpha^2 = \frac{\dfrac{e^2}{4\pi\varepsilon_0 m_e c^2}}{\dfrac{e^2}{8\pi\varepsilon_0 |E_1|}} = \frac{2|E_1|}{m_e c^2}, \quad \boxed{\alpha = \sqrt{\frac{2|E_1|}{m_e c^2}}}. \tag{23}$$

Inserting $|E_1| = 13.605693\ \text{eV}$ and $m_e c^2 = 510998.95\ \text{eV}$ gives $\alpha = 7.297352 \times 10^{-3}$, matching the measured fine structure constant to high precision. Thus α emerges directly from the single empirical datum $|E_1|$ and the NUVO geometric coherence condition.

Action derivation and calibration of $\mathcal{A}$. From the coherence rule (Section 3),

$$2\pi\mathcal{A} = N_* \Delta S_{\text{orbit}}, \quad \Delta S_{\text{orbit}} = p_B \Delta s,$$

with $p_B = m_e v$ the orbital momentum. Using circular-orbit kinematics,

$$v = \sqrt{\frac{2|E_1|}{m_e}},$$

and substituting $\Delta s = 2\pi r_e$ and $N_* = a_0/r_e$ gives

$$2\pi\mathcal{A} = \frac{a_0}{r_e}(m_e v)(2\pi r_e) = 2\pi(m_e v a_0) \Rightarrow \boxed{\mathcal{A} = m_e v a_0}. \tag{24}$$

Equation (24) expresses the universal coherence constant entirely in terms of measurable quantities m_e, v, a_0.

Substituting the expressions for a_0 and v obtained from $|E_1|$,

$$\mathcal{A} = m_e \sqrt{\frac{2|E_1|}{m_e}} \frac{e^2}{8\pi\varepsilon_0 |E_1|} = \frac{e^2}{8\pi\varepsilon_0} \sqrt{\frac{2m_e}{|E_1|}}. \tag{25}$$

Numerically, $\mathcal{A} = 1.0545718 \times 10^{-34}\ \mathrm{J \cdot s}$, identical to the measured $\hbar$ within experimental precision. Because $\mathcal{A}$ was derived entirely from geometric coherence and a single empirical input (13.6 eV), the equality

$$\boxed{\mathcal{A} = \hbar} \tag{26}$$

is a result rather than an assumption: the quantum of action arises naturally from scalar coherence in NUVO space.

Summary of assumptions. 1) The scalar modulation $\lambda = \gamma + \Phi_g$ includes only the special-relativistic Lorentz factor $\gamma = \left(1 - v^2/c^2\right)^{-1/2}$ and the gravitational potential term $\Phi_g = GM/\left(rc^2\right)$; electromagnetic forces do not appear in λ and enter only through the orbital kinematics $v(r)$ in (17). 2) The gravitational contribution is negligible for atomic systems ($\Phi_g \sim 10^{-45}$ for hydrogen). 3) The expansion $\lambda^2 = 1/\left(1 - r_e/r\right) \approx 1 + r_e/r$ neglects terms of order $O\left(r_e^2/r^2\right) \sim O\left(\alpha^4\right)$, which lie far below the leading precision of the analysis. 4) The derivations of α and $\mathcal{A}$ therefore rest on a single empirical datum ($|E_1| = 13.6\ \mathrm{eV}$) and the geometric closure condition $N_* \Delta s = 2\pi a_0$, with no additional physical postulates.

6. Discussion

While the quantization structure itself follows directly from the geometric coherence condition, the numerical scale of the quantum—embodied in the fine-structure constant and the reduced Planck constant—is fixed by empirical calibration using the hydrogen ground state. The theory thus introduces no extra physical postulates beyond geometry, but it adopts observational normalization to establish absolute magnitudes.

Geometric origin of α. The fine structure constant is obtained directly from the empirical hydrogen ground-state energy and the constant geometric advance $\Delta s = 2\pi r_e$. Equation (23) shows that $\alpha^2 = 2|E_1|/\left(m_e c^2\right)$, expressing α as the square root of the ratio of binding energy to rest energy. This relation connects a purely geometric quantity—the closure ratio a_0/r_e—with measurable physical parameters, providing a dimensionless bridge between scalar curvature and atomic energy.

Geometric origin of $\hbar$. The coherence constant $\mathcal{A}$ defined by the integral condition $\oint_\gamma \theta = 2\pi n \mathcal{A}$ is found from first principles to be $\mathcal{A} = m_e v a_0$. Eliminating v and a_0 through the same empirical datum $|E_1|$ yields

$\mathcal{A} = \frac{e^2}{8\pi\varepsilon_0}\sqrt{\frac{2m_e}{|E_1|}}$, which numerically equals $\hbar$. Thus the universal quantum of action appears as the measure of scalar coherence in NUVO space—a geometric constant fixed by one closed-orbit condition and one observed energy level.

Physical interpretation. In this view, α and $\hbar$ are not independent empirical constants but derived geometric invariants of the scalar conformal structure. The parameter α determines how many orbits are required for global closure ($N_* = 1/\alpha^2$), while $\hbar$ measures the total action accumulated in that closure ($2\pi\hbar$). Their values are therefore consequences of the same underlying geometry rather than separately fitted quantities. The interpretation of quantization as a topological closure condition has precedents in conformal and geometric frameworks [7] [8], but in NUVO space it arises directly from scalar coherence rather than gauge connection or field quantization.

Remark on instantaneous velocity. In the NUVO formulation the velocity appearing in $\lambda = \gamma + \Phi_g$ is the *instantaneous* velocity of the local frame along the worldline, not an orbital average or expectation value. The scalar modulation therefore represents the instantaneous geometric response of the conformal metric to local motion. Consequences of this property—including the treatment of fluctuating or radiative trajectories—will be developed in subsequent studies, but the distinction is noted here because it underlies the geometric coherence principle established above.

Local and global coherence. The quantization condition in NUVO space unites two levels of structure: a *local* modulation of the scalar field, $\lambda(x) = 1 + (T - V_g)/E_0$, describing the instantaneous geometry of each worldline, and a *global* closure condition, $\oint_\gamma \theta = 2\pi n \mathcal{A}$, ensuring that the conformal frame returns to its initial state after one complete orbit. Quantization arises from the compatibility of these two regimes—the local scalar dilation and the global holonomy of the conformal metric—so that discrete action represents the unique configuration in which both local and global consistency are simultaneously satisfied.

Scope and calibration. The hydrogen ground state was used here solely as a reference system because it represents the simplest closed scalar loop and provides the most precise empirical datum for calibration. The use of the 13.6 eV rest energy fixes the geometric scale but does not exhaust the predictive content of the framework. Subsequent papers will extend the same coherence principle to multi-loop and radiative configurations, where the derived constants α and $\hbar$ are expected to govern excited states, angular momentum coupling, and depletion phenomena without additional empirical input.

Broader implications. These results suggest that quantization originates in the topology of the scalar field, not in the introduction of operator mechanics. The discrete structure of atomic energy levels corresponds to the integer holonomy of the conformal frame, and $\hbar$ represents the unit of scalar action associated with that holonomy. Future work will extend this formulation to time—dependent and radiative scalar loops, explore its relation to photon exchange and field depletion, and investigate whether the same coherence principle accounts for quantization in broader relativistic and cosmological settings.

7. Conclusions

This study has shown that quantization arises in NUVO space from the geometric coherence of the scalar field itself. Starting from the relativistic modulation $\lambda = \gamma + \Phi_g$ and the conformal metric $g_{\mu\nu} = \lambda^2 \eta_{\mu\nu}$, the scalar geometry produces a constant per-orbit advance $\Delta s = 2\pi r_e$ independent of orbital radius. Imposing global closure of the conformal frame yields the fine structure constant α

directly from the empirical hydrogen ground-state energy, $\alpha^2 = 2|E_1|/(m_e c^2)$, and determines the universal coherence constant $\mathcal{A} = m_e v a_0$, which numerically equals $\hbar$. Both α and $\hbar$ therefore emerge as geometric invariants of the scalar conformal structure rather than as external postulates.

The analysis remains entirely within classical differential geometry: no operator formalism or probabilistic interpretation is invoked. Quantization appears as a topological property of scalar curvature, fixed by the integer holonomy of the unit-constrained frame. This establishes a concrete link between relativistic geometry and discrete action, forming the mathematical basis for the subsequent development of dynamic and radiative scalar loops.

Future work (NUVO Quantization II) will extend the coherence principle to time-dependent scalar fields, investigate the exchange of scalar action in open and radiative loops, and explore how the same geometric framework describes photon emission, absorption, and depletion phenomena.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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Appendix

Holonomy Formulation of Scalar Coherence

Let $\lambda(x)$ be the scalar field defining the conformal metric $g_{\mu\nu} = \lambda^2 \eta_{\mu\nu}$. Define the scalar connection one-form

$$\theta_\mu = \partial_\mu \ln \lambda, \ \mathcal{A} = \theta_\mu \mathrm{d}x^\mu.$$

Parallel transport of a unit scalar s along a path γ satisfies

$$\nabla_\mu^\lambda s = \partial_\mu s - \theta_\mu s = 0,$$

so that after one closed loop γ

$$s(\gamma_{\text{end}}) = s(\gamma_{\text{start}}) \exp\left(\oint_\gamma \theta_\mu \mathrm{d}x^\mu\right).$$

The exponential defines the holonomy of the scalar connection:

$$\mathrm{Hol}_\gamma(\mathcal{A}) = \mathrm{e}^{\oint_\gamma \theta}.$$

Coherence of the scalar unit requires the transported value to return identically, $\mathrm{Hol}_\gamma(\mathcal{A}) = 1$, implying the integrality condition

$$\oint_\gamma \theta = 2\pi n A, \ n \in \mathbb{Z},$$

where A is a universal scalar amplitude. If the connection is exact ($\theta = \mathrm{d}\ln\lambda$), its curvature two-form

$$F = \mathrm{d}\theta = 0$$

corresponds to a flat region of NUVO space; non-zero F produces quantized curvature flux

$$\frac{1}{2\pi}\int_\Sigma F = n,$$

analogous to the integral Chern number in geometric quantization.

This representation identifies the NUVO coherence condition as a holonomy quantization of the scalar connection. Quantization thus emerges from the topology of the λ-field rather than from an external postulate, providing a geometric complement to the empirical calibration discussed in Section 3.