

Temporal Reconstruction of Hydrogen I: Alpha-Free Proton–Electron Record Geometry

A Self-Contained Dual-Time Theory Manuscript for Neutral Temporal Resonance, Phase Opposition, Branch Orientation, and Post-Freeze Spectroscopy Interfaces

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June 2026 – expanded Paper 11 draft

Abstract

This paper is the first hydrogen manuscript in the Dual-Time Theory (DTT) constants-and-hydrogen sequence. Its purpose is deliberately narrower and more foundational than a derivation of the hydrogen spectrum. We construct an alpha-free temporal reconstruction of the hydrogen atom as a stable neutral proton–electron record resonance inside a dual-time projection architecture. The guiding principle is that hydrogen may supply physical ontology, finite record variables, temporal phase-locking language, and branch-orientation support, but it must not be used to derive the fine-structure constant by inserting the fine-structure constant into the inner-time tick, Bohr radius, Rydberg scale, Lamb-shift formula, or any equivalent spectroscopy datum.

The paper therefore separates two layers. The first layer, developed here, is an alpha-free neutral-pair reconstruction problem. It defines regulated proton and electron record complexes, compact inner phases, temporal Dirac-type record operators, phase-opposition support, neutral-pair resonance cycles, charge-conjugate orientation, and a functorial descent from neutral-pair data to the electron orientation data used in the holonomy-fraction program. The second layer, deferred to later hydrogen papers, is post-freeze numerical spectroscopy: once the constants c_* , $\hbar$, m_e , and α have been supplied by upstream DTT modules or by an explicitly labeled calibration, one may recover Bohr, Rydberg, fine-structure, and Lamb-shift formulas as downstream phenomenology.

The central theorem targets are: (i) a neutral temporal resonance criterion selecting stable hydrogenic record classes without electromagnetic spectral input; (ii) a phase-opposition orientation functional computable before any holonomy determinant phase is evaluated; (iii) a finite-regulator certificate for alpha-free hydrogen record geometry; and (iv) a source firewall proving that all alpha-containing hydrogen formulas are quarantined until after the electron holonomy certificate is frozen. The paper is intentionally status-disciplined. It does not claim a completed derivation of the measured hydrogen spectrum, the fine-structure constant, the Lamb shift, the proton radius, or the proton–electron mass ratio. It supplies the alpha-free record-geometric interface that those later derivations must pass through.

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1 Reader guide and claim-status discipline

This manuscript is Paper 11 in the DTT constants-and-hydrogen sequence. It follows the projection-realism, projection-metrology, action, $\hbar$, finite-stability, $c_\star$, structural 137, holonomy-fraction, coupling-correspondence, and physical-electron-certificate papers. It begins the hydrogen subseries.

One-sentence purpose

Hydrogen is treated here as a *neutral temporal record resonance* whose alpha-free structure can be defined before the fine-structure constant, Bohr radius, Rydberg constant, and Lamb-shift numerics are used.

1.1 Why this paper exists

The earlier hydrogen drafts contain valuable physical intuition: hydrogen is not primarily a little spatial orbit but a coherent temporal resonance generated by inner-time reconstruction, with proton and electron temporal phases, spectral operators, phase opposition, and emission as a transition between temporal modes. Those ideas are important for DTT. They are also dangerous if used too early, because some earlier formulas define an inner-time tick by

$$\Delta t_r = \alpha \frac{\hbar}{m_e c^2}, \quad (1)$$

then use that tick to recover hydrogen spectroscopy. Such a formula may be useful after α has been derived or calibrated; it cannot be part of a non-circular derivation of α .

The present paper extracts the safe core: proton/electron temporal phase variables, neutral-pair resonance, temporal Dirac-type spectra, orientation, phase opposition, and finite record cycles. It places every alpha-containing numerical hydrogen formula behind a firewall.

1.2 Three levels of assertion

Label	Meaning in this paper
Definition	A finite-regulator or continuum object is introduced as part of the alpha-free hydrogen interface.
Conditional theorem	A result proved from stated assumptions or from finite-regulator data.
Theorem target	A required result for a future full DTT derivation. The paper explains what must be proved but does not claim it is already proved.
Phenomenological placeholder	A downstream spectroscopy or comparison formula allowed only after the upstream constants have been derived or explicitly calibrated.
Forbidden pre-freeze input	A formula or number that contains α , Rydberg data, Bohr-scale data, Lamb-shift numerics, measured charge normalization, or equivalent electromagnetic-coupling information.

1.3 Main deliverables

This paper delivers:

1. a self-contained alpha-free ontology of hydrogen as a neutral proton–electron temporal record pair;
2. a finite-regulator data contract for hydrogenic record geometry;
3. a temporal phase-locking criterion that does not insert α ;
4. a temporal Dirac-type record operator and spectral-projector vocabulary;
5. a phase-opposition support and orientation functional;
6. a descent theorem target connecting neutral-pair orientation to the electron branch orientation used by the holonomy-fraction module;
7. a quarantine theorem separating alpha-free temporal geometry from post-freeze spectroscopy;
8. a machine-checkable alpha-free hydrogen certificate template and validation protocol;
9. a figure plan for the hydrogen subseries.

1.4 What this paper does not claim

Non-claims

This manuscript does not claim to derive α , the measured hydrogen spectrum, the Rydberg constant, the Bohr radius, the Lamb shift, the proton radius, QED radiative coefficients, the proton–electron mass ratio, or the measured electron charge. It defines the alpha-free temporal record structure that later papers must use without circularity.

2 Position in the DTT constants-and-hydrogen sequence

2.1 Upstream dependencies

The upstream papers provide a controlled environment for hydrogen:

- Papers 1–2 define dual-time projection realism and projection metrology.
- Papers 3–5 define the action–phase bridge, $\hbar$, and finite-stability corrections.
- Paper 6 defines $c_\star$ as a local-completion causal-cone invariant.
- Paper 7 supplies the structural integer 137 by canonical complexification and projection rigidity.
- Papers 8–10 formulate the holonomy fraction, coupling correspondence, and physical electron certificate.

The hydrogen program must not undo the non-circular discipline of Papers 8–10. Hydrogen can become the experimental arena where the constants become visible, but it cannot be the hidden source of the constants if the hydrogen formulas already contain them.

2.2 Downstream papers

The next hydrogen papers will use this alpha-free structure differently:

- Paper 12: once α , $\hbar$, $c_\star$, and m_e are upstream outputs or explicit calibrations, derive the Bohr spectrum and Rydberg scale as downstream consequences.

- Paper 13: reconstruct fine structure, Lamb shift, and radiative temporal loops with clear separation between standard QED recovery and new DTT residuals.
- Paper 14: use hydrogen, deuterium, Rydberg states, and antihydrogen as differential tests of the holonomy fraction, without line-by-line fitting.

2.3 Master logical split

$$\begin{array}{c}
 \boxed{\begin{array}{c} \text{Paper 11: alpha-free hydrogen temporal record geometry} \\ \Downarrow \\ \text{Papers 12–14: post-freeze spectroscopy and differential tests} \end{array}} \quad (2)
 \end{array}$$

This split is the core defense against circularity.

3 Source firewall and safe import ledger

3.1 Safe and unsafe imports

The source stack contains three kinds of hydrogen material.

Source role	Safe import into Paper 11	Quarantined until later
SMM/DTT hydrogen temporal model	Hydrogen as temporal resonance; temporal Dirac language; proton/electron phases; phase opposition; photon emission as spectral transition.	Any numerical spectrum if it uses α , a_0 , R_∞ , Lamb-shift values, or fitted transition data.
Hydrogen tick/spectrum drafts	Figure ideas; inner-time loop vocabulary; motivation for post-freeze spectroscopy.	$\Delta t_r = \alpha \hbar / (m_e c^2)$, Bohr formula as a derivation input, Rydberg numerical comparisons, Lamb-shift numerical matching.
Holonomy-fraction and mother papers	Source firewall; neutral-pair orientation as candidate support; requirement that branch orientation be fixed before determinant comparison.	Using hydrogen spectra to select the electron holonomy cycle, connection, low band, branch, or residual.
Projection-metrology papers	Constants-as-bridges; stable records; dimensionless vs dimensionful derivation distinction.	Treating SI numerical constants as pure dimensionless predictions.

Firewall Warning 3.1 (Alpha-containing hydrogen formulas are downstream). *Any formula of the following types is post-freeze only:*

$$\Delta t_r = \alpha \frac{\hbar}{m_e c^2}, \quad a_0 = \frac{\hbar}{m_e c \alpha}, \quad R_\infty = \frac{m_e \alpha^2 c}{2 \hbar}, \quad E_n = -\frac{m_e c^2 \alpha^2}{2 n^2}, \quad (3)$$

plus Lamb-shift, fine-structure, isotope-shift, or proton-radius numerics inferred from measured hydrogen spectra.

3.2 Allowed alpha-free variables

The following variables are allowed because they do not require numerical α :

$$\theta_{p,r}, \quad \theta_{e,r}, \quad U_{p,r} = e^{+i\theta_{p,r}}, \quad U_{e,r} = e^{-i\theta_{e,r}}, \quad D_{H,r}^{\text{temp}}, \quad P_{n,r}, \quad C_{H,r}, \quad \mathcal{O}_{H,r}^{\text{pe}}. \quad (4)$$

They are structural phase, spectral, projector, cycle, and orientation data. They become physical only when constructed from finite DTT records rather than inserted from measured spectra.

3.3 Operational removal test

Criterion 3.2 (Hydrogen firewall removal test). *Remove from the pre-freeze file system all measured values of α , all electron-anomaly data, all quantum-Hall constants, all Rydberg data, all Bohr-radius data, all Lamb-shift and fine-structure numerics, and all hydrogen transition frequencies. The constructor for the alpha-free hydrogen certificate must still produce the same serialized neutral-pair record geometry and orientation sign.*

4 Dual-time background for hydrogen

4.1 Generative layer and record layer

DTT begins with a role separation:

$$\Pi : \mathcal{G} \longrightarrow \mathcal{R}, \quad (5)$$

where $\mathcal{G}$ denotes the generative inner-time layer and $\mathcal{R}$ denotes the stable projected record layer. Observable physics is reconstructed from stable records, not from direct access to the generative substrate.

For hydrogen, the generative layer contains proton and electron reconstruction resources. The record layer contains stable neutral-pair events: preparation, persistence, transition, emission, absorption, and readout.

4.2 Inner order and outer record order

Inner time is not the same as laboratory time. It is the order in which generative reconstruction resources update. Outer time is the order of stable records after projection. A hydrogenic record history is therefore not a particle trajectory in a pre-existing space; it is a stable sequence of neutral-pair records whose projected order supports ordinary temporal description.

Definition 4.1 (Hydrogenic record history). *A regulated hydrogenic record history is a finite composable sequence*

$$\Gamma_{H,r} = (O_{0,r} \rightarrow O_{1,r} \rightarrow \cdots \rightarrow O_{N,r}) \quad (6)$$

of stable neutral-pair records, together with a compatible inner-phase assignment to the proton and electron components along each record morphism.

4.3 Why spatial orbits are not primitive

The standard classroom picture describes hydrogen using a spatial wavefunction, Coulomb potential, and quantum numbers. DTT does not reject that as an effective description. It asks for a deeper reconstruction: what stable temporal record structure gives rise to those effective quantum numbers and spatial observables?

The alpha-free target is not:

$$\text{electron literally orbits proton at speed } \alpha c. \quad (7)$$

The alpha-free target is:

$$\begin{aligned} &\text{hydrogen is a stable neutral temporal resonance} \\ &\text{whose projected observables later reproduce hydrogenic quantum numbers.} \end{aligned} \quad (8)$$

5 Primitive alpha-free hydrogen data

5.1 Regulated neutral-pair datum

Definition 5.1 (Alpha-free hydrogen datum). *A regulated alpha-free hydrogen datum is a tuple*

$$\mathcal{D}_{H,r} = (\mathcal{R}_{p,r}, \mathcal{R}_{e,r}, \mathcal{R}_{H,r}, J_r, \Theta_{p,r}, \Theta_{e,r}, \partial_r, \omega_r, \sim_{\text{obs},r}, \chi_r), \quad (9)$$

where:

- $\mathcal{R}_{p,r}$ and $\mathcal{R}_{e,r}$ are regulated proton and electron record complexes;
- $\mathcal{R}_{H,r}$ is their neutral-pair compatibility complex;
- J_r is the compatible complex structure inherited from the positive-energy reconstruction sector;
- $\Theta_{p,r}$ and $\Theta_{e,r}$ are compact inner-phase cochains;
- ∂_r is the finite incidence boundary operator;
- ω_r is an orientation/weighting system on cells;
- $\sim_{\text{obs},r}$ is observational equivalence;
- χ_r is a neutral compatibility character.

No component of $\mathcal{D}_{H,r}$ may be chosen using α , R_∞ , a_0 , transition frequencies, Lamb-shift data, or electron-anomaly data.

5.2 Record complexes

For each regulator r , write:

$$\mathcal{R}_{s,r} = (V_{s,r}, E_{s,r}, F_{s,r}, \partial_{s,r}, \omega_{s,r}), \quad s \in \{p, e, H\}. \quad (10)$$

Vertices represent stable local record states. Edges represent admissible record morphisms. Faces represent compatibility relations among morphisms. The hydrogen complex $\mathcal{R}_{H,r}$ is not the Cartesian product of the proton and electron complexes; it is the subcomplex selected by neutral compatibility, phase-lock admissibility, and observer-stable projection.

5.3 Neutral compatibility character

Definition 5.2 (Neutral compatibility character). *The neutral compatibility character is a map*

$$\chi_r : E_{p,r} \times E_{e,r} \longrightarrow U(1) \quad (11)$$

which records whether a proton edge and an electron edge can form a stable neutral-pair edge. A pair (a, b) is admissible when $\chi_r(a, b)$ lies in the distinguished neutral sector $\mathcal{N}_r \subset U(1)$.

Remark 5.3. *The neutral compatibility character is not the measured electric charge. It is the record-level character that makes a proton/electron pair neutral in the projected sector. Any later identification with electromagnetic charge requires the primitive charge-character paper and the coupling-correspondence theorem.*

5.4 Minimal data-contract table

Symbol	Alpha-free role
$\mathcal{R}_{p,r}$	Regulated proton record complex.
$\mathcal{R}_{e,r}$	Regulated electron record complex.
$\mathcal{R}_{H,r}$	Neutral-pair compatibility complex.
$\Theta_{p,r}$	Proton compact phase cochain; sign convention chosen before spectra.
$\Theta_{e,r}$	Electron compact phase cochain; retrograde convention allowed only as structural orientation, not as fitted charge.
χ_r	Neutral compatibility character.
$D_{H,r}^{\text{temp}}$	Temporal Dirac-type operator on hydrogenic record sections.
$P_{n,r}$	Spectral projectors of $D_{H,r}^{\text{temp}}$, not hydrogen energy projectors until post-freeze matching.
$C_{H,r}$	Neutral resonance cycle.
$\mathcal{O}_{H,r}^{\text{pe}}$	Phase-opposition orientation functional.

6 Temporal phases and neutral resonance

6.1 Proton and electron phase conventions

The safe temporal vocabulary uses opposite orientation conventions:

$$U_{p,r}(\sigma) = e^{+i\theta_{p,r}(\sigma)}, \quad U_{e,r}(\sigma) = e^{-i\theta_{e,r}(\sigma)}. \quad (12)$$

The sign difference is not a numerical charge normalization. It is an orientation convention for neutral temporal pairing.

Definition 6.1 (Pair phase). *For a finite neutral-pair cell $\sigma \in F_{H,r}$, define the pair phase*

$$\Phi_{pe,r}(\sigma) = \theta_{p,r}(\sigma) + \theta_{e,r}(\sigma) \in \mathbb{R}/2\pi\mathbb{Z}. \quad (13)$$

The sign convention in (12) means that phase opposition corresponds to antipodal support of the combined neutral-pair phase.

6.2 Phase-opposition support

Definition 6.2 (Phase-opposition support). *The phase-opposition support is the finite set*

$$\text{Opp}_r := \{\sigma \in F_{H,r} : \cos \Phi_{pe,r}(\sigma) < 0\}. \quad (14)$$

It records where proton and electron temporal phases are antipodal in the neutral resonance sense.

Definition 6.3 (Strong phase-lock support). *For a tolerance $\varepsilon_r > 0$, the strong neutral phase-lock support is*

$$\text{Lock}_r(\varepsilon_r) := \{\sigma \in F_{H,r} : \text{dist}(\Phi_{pe,r}(\sigma), \pi + 2\pi\mathbb{Z}) \leq \varepsilon_r\}. \quad (15)$$

A regulator trajectory is phase-locking when $\varepsilon_r \rightarrow 0$ and the weighted complement of $\text{Lock}_r(\varepsilon_r)$ tends to zero.

6.3 Neutral temporal resonance

Definition 6.4 (Alpha-free neutral temporal resonance). *A regulated neutral temporal resonance is a triple*

$$\mathfrak{H}_r = (\mathcal{D}_{H,r}, C_{H,r}, \mathcal{E}_{H,r}) \quad (16)$$

where $C_{H,r}$ is a closed neutral-pair record cycle and $\mathcal{E}_{H,r}$ is a stable finite-dimensional resonance subspace such that:

- (R1) $C_{H,r}$ is canonically constructed from $\mathcal{D}_{H,r}$;
- (R2) the pair phase along $C_{H,r}$ has regulator-stable winding class;
- (R3) the resonance subspace $\mathcal{E}_{H,r}$ is isolated by an alpha-free spectral or block-detectability criterion;
- (R4) the phase-opposition support is nonempty and regulator-stable;
- (R5) no hydrogen spectral number is used to select $C_{H,r}$, $\mathcal{E}_{H,r}$, or the branch orientation.

6.4 Resonance existence theorem target

Theorem Target 6.5 (Neutral temporal resonance theorem). *For sufficiently fine regulators there exists a canonical neutral temporal resonance $\mathfrak{H}_r$ constructed functorially from primitive DTT neutral-pair data. The regulator limit defines a stable hydrogenic record class*

$$\mathfrak{H} = \lim_{r \rightarrow \infty} \mathfrak{H}_r \quad (17)$$

without using α , Bohr/Rydberg data, or measured transition frequencies.

7 Temporal Dirac-type operators

7.1 Motivation

The earlier SMM hydrogen model suggests that hydrogenic structure can be encoded by a temporal Dirac operator on a sequence Hilbert space. In this paper that idea is retained only as alpha-free spectral vocabulary. The eigenvalues are not yet identified with measured hydrogen energies.

7.2 Finite record Hilbert space

Definition 7.1 (Hydrogenic record Hilbert space). *Let*

$$\mathcal{H}_{H,r} := \ell^2(V_{H,r}; \mathbb{C}^{m_r}) \quad (18)$$

be the finite Hilbert space of record sections over the neutral-pair vertices, with fiber dimension m_r fixed by the DTT reconstruction sector and not by fitting spectroscopy.

7.3 Temporal Dirac-type operator

Definition 7.2 (Temporal Dirac-type record operator). *A temporal Dirac-type record operator is a finite self-adjoint operator*

$$D_{H,r}^{\text{temp}} : \mathcal{H}_{H,r} \rightarrow \mathcal{H}_{H,r} \quad (19)$$

with the following structural form:

$$D_{H,r}^{\text{temp}} = J_r \nabla_{H,r}^{\text{rec}} + \mathcal{M}_{H,r} + \mathcal{V}_{H,r}^{\text{neutral}}. \quad (20)$$

Here J_r is the selected complex structure, $\nabla_{H,r}^{\text{rec}}$ is a record-difference operator on $\mathcal{R}_{H,r}$, $\mathcal{M}_{H,r}$ is a rest-recurrence block, and $\mathcal{V}_{H,r}^{\text{neutral}}$ is a neutral compatibility potential. Each term must be built from $\mathcal{D}_{H,r}$ without alpha-containing spectroscopy.

Definition 7.3 (Spectral projectors). *Let*

$$D_{H,r}^{\text{temp}} = \sum_k \lambda_{k,r} P_{k,r} \quad (21)$$

be the spectral decomposition. The projectors $P_{k,r}$ are hydrogenic temporal record projectors. They are not yet physical energy-level projectors until a later matching theorem maps them to the post-freeze hydrogen spectrum.

7.4 Allowed and forbidden spectral formulas

Allowed:

$$D_{H,r}^{\text{temp}} \psi_{k,r} = \lambda_{k,r} \psi_{k,r}, \quad P_{k,r} = |\psi_{k,r}\rangle \langle \psi_{k,r}|, \quad (22)$$

with $\lambda_{k,r}$ obtained from the finite record operator.

Forbidden before freeze:

$$\lambda_n = \lambda_0 - \frac{A\alpha^2}{n^2}, \quad \lambda_{n\ell j} = \lambda_n + \alpha^4 F(n, \ell, j), \quad \lambda_{2S} - \lambda_{2P} = \text{measured Lamb shift}. \quad (23)$$

7.5 Spectral stability condition

Definition 7.4 (Alpha-free spectral stability). *A finite family of projectors $\{P_{k,r}\}_{k \in K}$ is alpha-free stable along a regulator trajectory when there exist comparison maps $W_{r \rightarrow r'}$ such that*

$$\|W_{r \rightarrow r'} P_{k,r} W_{r \rightarrow r'}^* - P_{k,r'}\| \leq \delta_{r,r'}, \quad \delta_{r,r'} \rightarrow 0, \quad (24)$$

and the relevant spectral gaps are bounded below by constants derived from $\mathcal{D}_{H,r}$, not from spectroscopy.

8 Bound states as record cycles, not orbits

8.1 Record cycles

Definition 8.1 (Neutral record cycle). *A neutral record cycle is a closed chain*

$$C_{H,r} = e_{1,r} + e_{2,r} + \cdots + e_{N,r}, \quad \partial C_{H,r} = 0, \quad (25)$$

inside $\mathcal{R}_{H,r}$, together with proton/electron phase cochains $\Theta_{p,r}$, $\Theta_{e,r}$ and neutral compatibility character χ_r .

8.2 Winding and stability

The cycle carries a pair-phase winding:

$$W_{pe,r}(C_{H,r}) = \frac{1}{2\pi} \sum_{e \in C_{H,r}} \Delta \Phi_{pe,r}(e) \in \mathbb{Z} + \varepsilon_r, \quad (26)$$

where $\varepsilon_r \rightarrow 0$ along admissible regulator refinements.

Definition 8.2 (Alpha-free principal quantum label). *An alpha-free principal temporal label is a stable winding or spectral-isolation label*

$$\nu_r \in \mathbb{Z}_{>0} \quad (27)$$

derived from $C_{H,r}$ and $D_{H,r}^{\text{temp}}$. It is not yet the ordinary principal quantum number n until a later post-freeze matching theorem identifies it with hydrogen spectroscopy.

8.3 No classical orbit premise

Remark 8.3 (Orbit language is downstream). *The cycle $C_{H,r}$ is not a literal circular electron orbit. It is a closed record chain in the projected neutral-pair complex. Ordinary orbit, radius, velocity, and Coulomb potential language may emerge later as semiclassical approximations, but they are not primitive in this paper.*

9 Spin, covering, and angular labels

9.1 Temporal covering data

DTT can encode spin-like structure as a temporal covering property rather than as a primitive spatial rotation of a point particle. We define a regulated covering index

$$\kappa_{s,r} : \pi_1(C_{H,r}) \longrightarrow \mathbb{Z}_2 \quad (28)$$

for $s \in \{p, e, H\}$. A nontrivial $\mathbb{Z}_2$ covering corresponds to sign reversal under a single loop and return after a double loop.

Definition 9.1 (Temporal spin support). *A temporal spin support is a subspace $\mathcal{H}_{H,r}^{\text{spin}} \subset \mathcal{H}_{H,r}$ carrying a nontrivial double-cover representation of the record-cycle loop group generated by $C_{H,r}$.*

9.2 Angular labels as projected stabilizers

Angular labels are introduced here as stabilizer labels of record-cycle symmetries, not as spatial spherical harmonics:

$$\ell_r, j_r, F_r \rightsquigarrow \text{irreducible labels of the finite stabilizer algebra } \mathfrak{A}_{H,r}. \quad (29)$$

Only after post-freeze matching may these be identified with the familiar ℓ, j, F of hydrogen spectroscopy.

9.3 Theorem target: angular-label emergence

Theorem Target 9.2 (Angular label emergence). *The continuum or completed-record limit of the finite stabilizer algebras $\mathfrak{A}_{H,r}$ admits a stable sector decomposition whose labels match the hydrogenic labels (n, ℓ, j, F) after the downstream constants and coupling are supplied. The matching must not use measured transition frequencies to define the sectors.*

10 Alpha-free orientation and branch support

10.1 Why orientation matters

The holonomy-fraction program requires an electron branch orientation chosen before the determinant phase is compared with the target residual. Hydrogen can help only if neutral-pair phase data descend to the electron orientation functional without using alpha-containing spectral information.

10.2 Neutral-pair orientation functional

Definition 10.1 (Neutral-pair orientation functional). *Let $\iota_\sigma \in \{\pm 1\}$ be the cell-incidence sign of $\sigma \in F_{H,r}$, let $w_\sigma > 0$ be its alpha-free weight, and let $\Pi_{\sigma,r}$ be the local support projector on the neutral-pair record fiber. Define*

$$\mathcal{O}_{H,r}^{\text{pe}} := \sum_{\sigma \in F_{H,r}} \iota_\sigma w_\sigma \operatorname{sgn}(\sin \Phi_{pe,r}(\sigma)) \operatorname{Tr}(P_{H,r}^{\text{neutral}} \Pi_{\sigma,r} P_{H,r}^{\text{neutral}}). \quad (30)$$

The sign $\operatorname{sgn} \mathcal{O}_{H,r}^{\text{pe}}$ is admissible as orientation support only if it is computed before any electron holonomy determinant phase or hydrogen spectral comparison is evaluated.

10.3 Electron orientation descent

Let $\mathcal{O}_{e,r}^{\text{can}}$ denote the canonical electron orientation functional from the physical electron certificate program. Hydrogen can support it only through a target-blind descent map:

$$\mathcal{D}_r^{\text{pe}} : \mathcal{D}_{H,r} \longrightarrow (J_r, \Sigma_{e,r}, P_r, \{t_{\sigma,r}^{\text{flat}}, t_{\sigma,r}^{\text{phys}}\}, \{\Pi_{\sigma,r}\}). \quad (31)$$

Theorem Target 10.2 (Neutral-pair orientation descent). *For sufficiently fine regulators, $\mathcal{D}_r^{\text{pe}}$ is functorial, target-blind, and satisfies*

$$\operatorname{sgn} \mathcal{O}_{H,r}^{\text{pe}} = \operatorname{sgn} \mathcal{O}_{e,r}^{\text{can}}. \quad (32)$$

No measured hydrogen transition frequency, no α -dependent tick formula, and no fine-structure residual may enter the construction of D_r^{pe} .

10.4 Use and limitation

If [theorem 10.2](#) is proved, hydrogen temporal resonance becomes legitimate support for the electron branch orientation. If not, hydrogen remains interpretive ontology, and the electron branch orientation must be established independently.

11 Charge conjugation and antihydrogen interface

11.1 Conjugate orientation sector

Let $\bar{J}_r = -J_r$ denote antiunitary orientation reversal at the regulated level. Define the conjugate neutral-pair datum

$$\bar{\mathcal{D}}_{H,r} = (\mathcal{R}_{\bar{p},r}, \mathcal{R}_{\bar{e},r}, \mathcal{R}_{\bar{H},r}, -J_r, -\Theta_{p,r}, -\Theta_{e,r}, \partial_r, \omega_r, \sim_{\text{obs},r}, \bar{\chi}_r). \quad (33)$$

Theorem Target 11.1 (Charge-conjugate orientation). *A complete hydrogen interface must prove that conjugate neutral-pair data satisfy*

$$\mathcal{O}_{\bar{H},r}^{\text{pe}} = -\mathcal{O}_{H,r}^{\text{pe}} \quad (34)$$

with physical spectra preserved after the appropriate charge-conjugation convention. Identifying $\bar{\mathcal{D}}_{H,r}$ with antihydrogen requires additional gauge and charge-sector data and is not assumed here.

11.2 Antihydrogen as a future test

Antihydrogen spectroscopy belongs to the post-freeze empirical layer. It cannot be used to select the alpha-free hydrogen datum, but it may later test whether the same temporal orientation and charge-conjugation rules produce the correct symmetry relations.

12 Finite-regulator hydrogen certificate

12.1 Certificate object

Definition 12.1 (Alpha-free hydrogen certificate). *A regulated alpha-free hydrogen certificate is*

$$\text{Cert}_{H,r} = (\mathcal{D}_{H,r}, C_{H,r}, D_{H,r}^{\text{temp}}, \{P_{k,r}\}_{k \in K_r}, \text{Opp}_r, \text{Lock}_r, \mathcal{O}_{H,r}^{\text{pe}}, D_r^{\text{pe}}, \mathcal{F}_r, h_r), \quad (35)$$

where $\mathcal{F}_r$ is the source-firewall ledger and h_r is the hash of the canonical serialization.

12.2 Admissibility requirements

A certificate is admissible only if:

- (H1) all primitive data are generated from DTT record constructors;
- (H2) no alpha-containing formula appears in pre-freeze fields;
- (H3) spectral projectors are derived from $D_{H,r}^{\text{temp}}$, not from measured energy levels;
- (H4) $C_{H,r}$ is closed and regulator-stable;
- (H5) $\mathcal{O}_{H,r}^{\text{pe}}$ is computed before any electron holonomy phase is evaluated;
- (H6) comparison maps between regulators are included;
- (H7) post-freeze spectroscopy fields are explicitly empty or quarantined;
- (H8) the canonical serialization hash is computed before any target comparison.

12.3 Machine-checkable schema

A machine-checkable schema should contain at least:

```
{
  "certificate_type": "alpha_free_hydrogen_temporal_resonance",
  "regulator_id": "r0_template",
  "primitive_data": {...},
  "uses_alpha": false,
  "pre_freeze_forbidden_inputs": [],
  "post_freeze_quarantine": [
    "Delta_t_r = alpha*hbar/(m_e*c^2)",
    "Bohr radius",
    "Rydberg constant",
    "Lamb shift numerics",
    "hydrogen transition frequencies"
  ],
  "orientation": {...},
  "spectral_data_status": "alpha_free_labels_only",
  "physical_spectrum_claim": false,
  "canonical_hash": "..."
}
```

12.4 Certificate acceptance theorem target

Theorem Target 12.2 (Alpha-free hydrogen certificate acceptance). *If $\text{Cert}_{H,r}$ satisfies H1–H8 along a regulator trajectory and the regulator comparison errors tend to zero, then the limiting object is a canonical alpha-free hydrogen temporal record geometry. This proves the existence of the hydrogen interface, not the numerical hydrogen spectrum.*

13 Regulator convergence and stability

13.1 Regulator maps

Let $r \preceq r'$ denote refinement. A regulator comparison map consists of:

$$\mathcal{W}_{r \rightarrow r'} = (W_{r \rightarrow r'}^V, W_{r \rightarrow r'}^E, W_{r \rightarrow r'}^F, W_{r \rightarrow r'}^{\mathcal{H}}). \quad (36)$$

These maps compare vertices, edges, faces, and Hilbert-space sections.

13.2 Stability norms

Define the regulator drift:

$$\Delta_{r,r'}^H := \|W_{r \rightarrow r'}^{\mathcal{H}} D_{H,r}^{\text{temp}} (W_{r \rightarrow r'}^{\mathcal{H}})^* - D_{H,r'}^{\text{temp}}\| + \max_{k \in K_r} \|W_{r \rightarrow r'}^{\mathcal{H}} P_{k,r} (W_{r \rightarrow r'}^{\mathcal{H}})^* - P_{k,r'}\| + |\mathcal{O}_{H,r}^{\text{pe}} - \mathcal{O}_{H,r'}^{\text{pe}}|. \quad (37)$$

Definition 13.1 (Regulator-stable hydrogen interface). *The alpha-free hydrogen interface is regulator-stable when there is a cofinal trajectory $r_1 \preceq r_2 \preceq \dots$ such that*

$$\Delta_{r_n, r_{n+1}}^H \rightarrow 0, \quad (38)$$

and all discrete orientation signs and neutral-pair winding labels stabilize.

14 Bridge to the holonomy-fraction program

14.1 What hydrogen may supply

The alpha-free hydrogen interface may supply:

- candidate electron/proton temporal phase variables;
- phase-opposition support;
- alpha-free branch-orientation support;
- neutral-pair cycle vocabulary;
- post-freeze excited-state cycle families for differential tests.

14.2 What hydrogen may not supply

Hydrogen may not select:

- the physical electron holonomy value H_e ;
- the residual target 0.035999177...;
- the electron record connection by fitting spectra;
- the determinant branch by matching CODATA;
- the low band by measured transition data.

14.3 Safe interface diagram

15 Post-freeze spectroscopy placeholder

This paper deliberately leaves numerical spectroscopy inactive. Still, it should record where later formulas will enter.

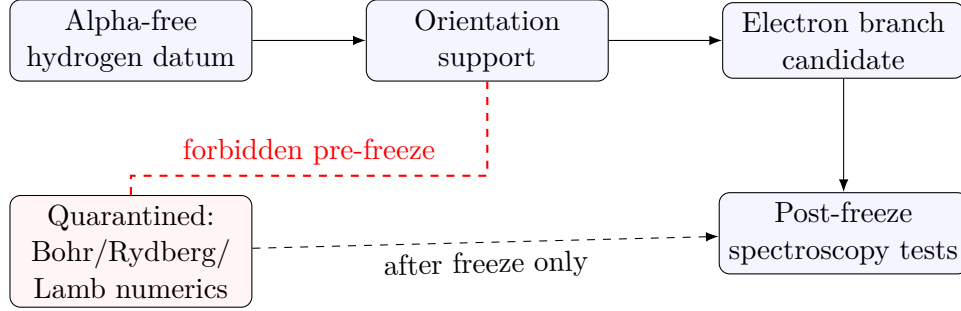


Figure 1: Safe hydrogen interface. Alpha-free temporal data may support orientation. Alpha-containing spectroscopy remains quarantined until after upstream constants or certificates are fixed.

15.1 Post-freeze activation rule

Criterion 15.1 (Post-freeze activation). *The following formulas may be activated only after α , $\hbar$, $c_\star$, and m_e have been supplied by upstream DTT derivations, frozen certificates, or explicitly labeled calibration:*

$$\Delta t_r = \alpha \frac{\hbar}{m_e c_\star^2}, \quad E_n = -\frac{m_e c_\star^2 \alpha^2}{2n^2}, \quad a_0 = \frac{\hbar}{m_e c_\star \alpha}, \quad R_\infty = \frac{m_e \alpha^2 c_\star}{2h}. \quad (39)$$

15.2 State labels before and after matching

Object	Paper 11 status	Post-freeze status
ν_r	Temporal winding/spectral label.	Principal quantum number n , if matching theorem proves it.
ℓ_r, j_r, F_r	Stabilizer labels of record-cycle symmetries.	Orbital, total, and hyperfine labels.
$\lambda_{k,r}$	Alpha-free temporal spectrum.	Energy/frequency scale after constants supplied.
$C_{H,r}$	Neutral record cycle.	Hydrogenic state cycle C_{nljF} .
$\mathcal{O}_{H,r}^{\text{pe}}$	Orientation support.	Branch and antihydrogen comparison support.

16 Hydrogenic record categories and functoriality

16.1 Why a categorical layer is needed

A hydrogen atom is normally described by a Hilbert space together with a Hamiltonian. In the present paper that description is too late in the logical chain, because a Hamiltonian with Coulomb strength already presupposes electromagnetic coupling. The alpha-free layer therefore starts one step earlier: it describes the category of stable neutral records and the functors that send generative proton/electron resources into record-level neutral-pair histories.

Definition 16.1 (Neutral-pair record category). *For each regulator r , the neutral-pair record category $\mathbf{H}_r$ has:*

- *objects*: stable neutral-pair record states $O \in V_{H,r}$;
- *morphisms*: admissible neutral record transitions $e : O \rightarrow O'$ in $E_{H,r}$;
- *two-morphisms*: record homotopies or compatibility faces $f \in F_{H,r}$;
- *composition*: concatenation of record transitions when endpoint data match;
- *involution*: a reversal operation $e \mapsto e^\dagger$ when the stable record admits a reversible comparison.

Definition 16.2 (Proton–electron pairing functor). *A proton–electron pairing functor is a partial functor*

$$\mathbf{P}_{pe,r} : \mathbf{P}_r \times \mathbf{E}_r \dashrightarrow \mathbf{H}_r \quad (40)$$

from proton and electron record categories to the neutral-pair record category. Its domain is selected by the neutral compatibility character χ_r . It is alpha-free when the selection rule depends only on record compatibility, phase orientation, and structural charges, not on measured hydrogen spectra.

Theorem Target 16.3 (Functorial neutral-pair construction). *The DTT hydrogen interface must construct $\mathbf{H}_r$ and $\mathbf{P}_{pe,r}$ functorially from primitive proton and electron record data. If $\varphi_r : \mathcal{D}_{H,r} \rightarrow \mathcal{D}'_{H,r}$ is an isomorphism of primitive data, then the induced categories and cycles must satisfy*

$$\mathbf{H}_r \simeq \mathbf{H}'_r, \quad \varphi_r(C_{H,r}) = C'_{H,r}, \quad \text{sgn } \mathcal{O}_{H,r}^{\text{pe}} = \text{sgn } \mathcal{O}_{H,r'}^{\text{pe}}. \quad (41)$$

This prevents arbitrary presentation choices from selecting the hydrogen orientation or resonance cycle.

16.2 Record homotopy and state identity

Two neutral record cycles should represent the same alpha-free hydrogenic state when they differ only by record homotopy inside the neutral compatibility complex.

Definition 16.4 (Neutral record homotopy). *Let $C_{H,r}$ and $C'_{H,r}$ be closed chains. They are neutral-homotopic when there exists a two-chain $S_{H,r}$ such that*

$$C'_{H,r} - C_{H,r} = \partial S_{H,r}, \quad (42)$$

and all cells of $S_{H,r}$ remain inside the neutral compatibility sector.

Lemma 16.5 (Pair phase is homotopy-stable modulo curvature). *If $\Phi_{pe,r}$ is a one-cochain and $C'_{H,r} - C_{H,r} = \partial S_{H,r}$, then*

$$\sum_{e \in C'_{H,r}} \Phi_{pe,r}(e) - \sum_{e \in C_{H,r}} \Phi_{pe,r}(e) = \sum_{f \in S_{H,r}} (d\Phi_{pe,r})(f). \quad (43)$$

Hence the pair-phase class is homotopy invariant when the pair curvature $d\Phi_{pe,r}$ vanishes on the comparison surface, and controlled when the curvature is bounded.

Proof. This is the discrete Stokes identity for finite cochains on $\mathcal{R}_{H,r}$. The important point is not the identity itself but its role: it provides a finite-regulator way to distinguish genuine resonance winding from arbitrary path drawing. $\square$

17 Neutral resonance isolation and finite-block verification

17.1 Why isolation matters

If a neutral resonance cycle can be chosen freely, the theory becomes a fitting scheme. A legitimate DTT hydrogen record must be selected by structural isolation. This section states a certificate-level route analogous to the low-band isolation requirements in the electron holonomy program, but adapted to neutral-pair resonance rather than the electron determinant phase.

17.2 Local neutral blocks

Let $\mathcal{B}_{H,r}$ be a finite cover of $\mathcal{R}_{H,r}$ by local blocks. Each block $B \in \mathcal{B}_{H,r}$ carries a restricted temporal operator $D_{B,r}^{\text{temp}}$, neutral compatibility projector $P_{B,r}^{\text{neutral}}$, and local resonance projector $P_{B,r}^{\text{res}}$.

Definition 17.1 (Local neutral gap). *A local neutral block has gap $\gamma_B(r) > 0$ when*

$$\text{dist}\left(\text{Spec}(D_{B,r}^{\text{temp}}|_{P_{B,r}^{\text{res}}}), \text{Spec}(D_{B,r}^{\text{temp}}|_{(I-P_{B,r}^{\text{res}})})\right) \geq \gamma_B(r). \quad (44)$$

Set $\gamma_*(r) = \min_{B \in \mathcal{B}_{H,r}} \gamma_B(r)$.

Definition 17.2 (Detectability contraction). *The local block projectors satisfy a detectability contraction with parameter $q_r < 1$ when repeated application of the nonresonant complements contracts vectors outside the global resonance sector:*

$$\left\| \prod_{B \in \mathcal{B}_{H,r}} (I - P_{B,r}^{\text{res}}) v \right\| \leq q_r \|v\| \quad (45)$$

for all v orthogonal to the global neutral resonance subspace.

Theorem Target 17.3 (Certificate-level neutral resonance gap). *Assume local gaps $\gamma_*(r) > 0$, detectability contraction $q_r < 1$, local-to-global overlap bound M_r , perturbation size ε_r , locality constant $C_{\text{loc}}(r)$, leakage ℓ_r , and high-sector gap Γ_r . Then the alpha-free hydrogen certificate should verify*

$$m_{H,\text{cert}}(r) = \frac{\gamma_*(r)}{M_r} (1 - q_r) - 2C_{\text{loc}}(r)\varepsilon_r - \frac{4\ell_r^2}{\Gamma_r} > 0. \quad (46)$$

A positive lower bound along the regulator trajectory certifies that the neutral resonance is structurally isolated.

17.3 Why this is not a spectrum fit

The gap bound (46) uses local record operators, compatibility projectors, and regulator estimates. It does not refer to measured hydrogen frequencies. Therefore it can be checked before spectroscopy is activated.

18 Preparation, transition, emission, and absorption records

18.1 Hydrogen as a record process

Hydrogen is not only a static bound state. It is also a system of preparation records, persistence records, transition records, and photon-coupled emission/absorption records. The alpha-free formulation must describe these processes without inserting transition frequencies.

Definition 18.1 (Preparation record). *A preparation record is a morphism*

$$\text{Prep}_{H,r} : O_r^{\text{in}} \longrightarrow O_r^{\text{neutral}} \quad (47)$$

whose image lies in the neutral resonance sector and whose stability is certified by the neutral gap condition.

Definition 18.2 (Transition record). *A transition record is a morphism between alpha-free temporal spectral sectors,*

$$\mathbb{T}_{k \rightarrow k',r} : P_{k,r} \mathcal{H}_{H,r} \longrightarrow P_{k',r} \mathcal{H}_{H,r}, \quad (48)$$

selected by record compatibility and stabilizer-label rules. It is not assigned a physical photon frequency until post-freeze constants and coupling are available.

Definition 18.3 (Emission character). *An emission character is an alpha-free compact record character*

$$\Xi_{k \rightarrow k',r} : \mathbb{T}_{k \rightarrow k',r} \longrightarrow U(1) \quad (49)$$

recording phase transfer between neutral resonance sectors and photon-like record sectors. It is not the measured electromagnetic amplitude.

Theorem Target 18.4 (Alpha-free transition selection). *Selection rules for allowed transitions should be derivable from the stabilizer algebra $\mathfrak{A}_{H,r}$, temporal covering data, and emission character $\Xi_{k \rightarrow k',r}$, without using measured spectral-line intensities or frequencies.*

19 Comparison with conventional hydrogen without circularity

19.1 Effective quantum-mechanical image

A later matching theorem should map alpha-free temporal record structures into the ordinary quantum description:

$$M_{\text{QM}} : (\mathcal{D}_H, C_H, D_H^{\text{temp}}, P_k, \mathfrak{A}_H) \longrightarrow (L^2(\mathbb{R}^3), H_{\text{eff}}, n, \ell, j, F). \quad (50)$$

This map is not assumed in Paper 11; it is a target for Paper 12.

19.2 What ordinary quantities become

Ordinary object	DTT alpha-free precursor	Activation condition
-----------------	--------------------------	----------------------

Wavefunction $\psi_{n\ell m}$	Record section over $\mathcal{R}_{H,r}$.	Continuum/projective matching.
Hamiltonian H	Temporal record operator $D_{H,r}^{\text{temp}}$.	Coupling and unit dictionary.
Coulomb potential	Neutral compatibility potential $\mathcal{V}_{H,r}^{\text{neutral}}$.	Charge-character theorem.
Energy eigenvalue	Temporal spectral label $\lambda_{k,r}$.	$\hbar, c_*, \alpha, m_e$ supplied.
Dipole selection rule	Stabilizer/emission-character rule.	Photon-record matching.
Radiative correction	Temporal-loop correction.	Post-freeze QED/DTT comparison.

19.3 Non-circular matching theorem target

Theorem Target 19.1 (Hydrogen quantum-mechanical image). *After upstream constants are supplied, the matching map M_{QM} sends the stable temporal labels of $D_{H,r}^{\text{temp}}$ to the usual hydrogenic labels and recovers the Schrödinger/Dirac effective description in the appropriate regime. The map must be fixed before comparing with precision transition data.*

20 Algorithmic construction protocol

20.1 Ordered protocol

A future implementation should proceed in this order:

- A1.** Construct primitive proton and electron record data.
- A2.** Construct the neutral compatibility character χ_r .
- A3.** Build the neutral-pair complex $\mathcal{R}_{H,r}$.
- A4.** Assign compact phase cochains $\Theta_{p,r}$ and $\Theta_{e,r}$ from record data.
- A5.** Construct closed neutral cycles $C_{H,r}$ by functorial rules.
- A6.** Build $D_{H,r}^{\text{temp}}$ and compute spectral projectors.
- A7.** Verify local gaps, detectability contraction, and resonance isolation.
- A8.** Compute phase-opposition support and orientation $\mathcal{O}_{H,r}^{\text{pe}}$.
- A9.** Serialize the alpha-free hydrogen certificate and compute its hash.
- A10.** Only after upstream constants are supplied, activate spectroscopy matching.

20.2 Pseudocode

```
def construct_alpha_free_hydrogen(D_p, D_e, regulator):
    chi = neutral_compatibility_character(D_p, D_e)
    R_H = build_neutral_pair_complex(D_p, D_e, chi)
    Theta_p, Theta_e = construct_phase_cochains(D_p, D_e, R_H)
    C_H = canonical_neutral_cycle(R_H, Theta_p, Theta_e)
    D_temp = temporal_dirac_operator(R_H, Theta_p, Theta_e, chi)
    projectors = spectral_projectors(D_temp)
```

```

gap_certificate = verify_neutral_gap(R_H, D_temp, projectors)
O_pe = phase_opposition_orientation(R_H, Theta_p, Theta_e, projectors)
certificate = serialize_without_spectroscopy(
    R_H, C_H, D_temp, projectors, gap_certificate, O_pe)
assert no_alpha_or_spectroscopy_inputs(certificate)
return freeze_hash(certificate)

```

21 Failure modes and repair routes

Failure mode	Meaning	Repair route
No canonical $\mathcal{R}_{H,r}$	Neutral-pair complex depends on arbitrary choices.	Strengthen primitive DTT constructor or weaken physical claim.
No stable neutral cycle	Hydrogenic resonance is not selected structurally.	Add missing compatibility data or reject interface.
No spectral gap	Temporal labels cannot be isolated.	Improve regulator/block theorem or treat as non-isolated regime.
Orientation descent fails	Hydrogen cannot support electron branch orientation.	Use independent electron orientation only.
Alpha contamination detected	A pre-freeze field contains spectroscopy or α .	Quarantine/remove field and rerun constructor.
Post-freeze matching fails	Alpha-free labels do not map to ordinary hydrogen.	The temporal hydrogen model is incomplete or wrong.
Line-by-line fitting needed	Spectroscopy has too many free amplitudes.	Reject predictive hydrogen residual claim.

22 Extended theorem-target ledger

Target	Required result	Status
Neutral-pair functor	Construct $\mathbf{H}_r$ functorially from proton/electron record categories.	Open
Neutral resonance	Prove existence of stable $C_{H,r}$ and resonance subspace.	Open
Temporal operator	Build $D_{H,r}^{\text{temp}}$ from record data only.	Target
Gap certificate	Verify $m_{H,\text{cert}}(r) > 0$.	Target
Phase opposition	Compute stable Opp_r .	Target
Orientation descent	Prove $\text{sgn } \mathcal{O}_{H,r}^{\text{pe}} = \text{sgn } \mathcal{O}_{e,r}^{\text{can}}$.	Open
Charge conjugation	Prove conjugate orientation and spectroscopy symmetry.	Open
QM image	Map alpha-free labels to (n, ℓ, j, F) after constants are supplied.	Later

23 Detailed assumption registry

The alpha-free hydrogen interface relies on assumptions that are weaker than a full hydrogen-spectrum derivation but stronger than a purely interpretive story. They are listed explicitly so that later papers can discharge or reject them.

Assumption	Content	How it can fail
A1	Proton and electron record categories exist as stable projected sectors.	DTT may lack a sector theorem for these objects.
A2	A neutral compatibility character can be defined before measured charge normalization.	Neutrality may depend on empirical electromagnetic input.
A3	Pair phases Θ_p, Θ_e are compact record cochains.	Phase variables may not descend functorially to records.
A4	Neutral record cycles are structurally selected.	Cycles may be nonunique or presentation-dependent.
A5	A temporal Dirac-type operator exists from record data.	Operator may be underdetermined or fitted.
A6	Neutral resonance projectors are isolated by alpha-free gaps.	Spectral labels may be unstable.
A7	Phase-opposition orientation is computed before holonomy or spectroscopy.	Orientation may be post-hoc.
A8	Alpha-free labels can later match ordinary hydrogen labels.	Temporal record labels may not reproduce quantum numbers.

How to read the assumptions

A1–A7 belong to Paper 11. A8 belongs to Paper 12. Failure of A8 would not necessarily invalidate the alpha-free temporal record construction, but it would block the claim that the construction is the hydrogen atom in the usual spectroscopic sense.

24 Alpha-free finite-cell worked example

This example is deliberately nonphysical. It demonstrates the format of a hydrogen certificate without asserting that the numbers represent real hydrogen.

24.1 Cells and phases

Let the neutral complex have four vertices v_0, v_1, v_2, v_3 , four oriented edges

$$e_0 : v_0 \rightarrow v_1, \quad e_1 : v_1 \rightarrow v_2, \quad e_2 : v_2 \rightarrow v_3, \quad e_3 : v_3 \rightarrow v_0, \quad (51)$$

and one comparison face f whose boundary is $e_0 + e_1 + e_2 + e_3$. Define

$$\Theta_p(e_k) = \frac{\pi}{4}(2k+1), \quad \Theta_e(e_k) = \pi - \frac{\pi}{4}(2k+1) + \epsilon_k. \quad (52)$$

Then

$$\Phi_{pe}(e_k) = \pi + \epsilon_k. \quad (53)$$

For $|\epsilon_k| < \pi/2$, all four edges lie in phase-opposition support.

24.2 Toy orientation value

Let weights be $w_k = 1$, incidence signs $\iota_k = +1$, and support traces equal to one. Then

$$\mathcal{O}_H^{\text{pe}} = \sum_{k=0}^3 \text{sgn}(\sin(\pi + \epsilon_k)) = - \sum_{k=0}^3 \text{sgn}(\epsilon_k). \quad (54)$$

The orientation is well-defined if the sign pattern is regulator-stable. It is undefined if the regulator drives all ϵ_k through zero without an independent orientation rule. This is not a defect of the example; it demonstrates why a physical branch theorem cannot be replaced by verbal intuition.

24.3 Toy certificate table

r	$\#V$	$\#E$	$\#F$	∂C_H	status
r_0	4	4	1	0	format test only
r_1	8	8	2	0	refinement placeholder
r_2	16	16	4	0	refinement placeholder

A real certificate would replace these placeholders by DTT-derived cells, phase cochains, operator matrices, gap constants, orientation signs, and regulator comparison maps.

25 Post-freeze spectroscopy staging plan

Even though spectroscopy is quarantined here, the paper should make clear how later work will use it.

25.1 Stage S0: alpha-free record construction

This is the present paper. It constructs $\mathcal{D}_{H,r}$, $C_{H,r}$, $D_{H,r}^{\text{temp}}$, $P_{k,r}$, and $\mathcal{O}_{H,r}^{\text{pe}}$ without spectroscopy.

25.2 Stage S1: constant activation

After upstream work supplies $\hbar$, $c_\star$, m_e , the charge character, and α , the dormant spectroscopy map may be activated. The activation step must be logged as post-freeze and cannot modify the alpha-free certificate hash.

25.3 Stage S2: effective Hamiltonian image

The temporal operator is mapped to an effective Hamiltonian:

$$D_{H,r}^{\text{temp}} \rightsquigarrow H_H^{\text{eff}} = H_0 + V_{\text{Coul}} + V_{\text{spin}} + V_{\text{rad}} + \cdots. \quad (55)$$

The symbols on the right are effective field-theory images, not primitive data.

25.4 Stage S3: overconstrained spectroscopy

The empirical layer should use overconstrained shape patterns, not line-by-line fitting. A legitimate residual model has a small number of derived shape columns:

$$\delta\nu_i = \sum_{a=1}^A c_a S_{ia}, \quad A \ll \#\{\text{measured transitions}\}, \quad (56)$$

where the shape columns S_{ia} are derived from temporal record cycles. A separate free coefficient for each transition is a failure.

26 Audit checklist for Paper 12 readiness

Before writing the post-freeze Bohr-spectrum paper, the following checklist should be satisfied.

- R1.** The alpha-free hydrogen certificate schema is frozen.
- R2.** The finite record complex $\mathcal{R}_{H,r}$ is populated for at least one nontrivial regulator family.
- R3.** The neutral cycle $C_{H,r}$ is closed and functorially selected.
- R4.** The temporal operator $D_{H,r}^{\text{temp}}$ is built from record data.
- R5.** Spectral projectors are isolated by an alpha-free gap certificate.
- R6.** $\mathcal{O}_{H,r}^{\text{pe}}$ is computed before any determinant phase or spectroscopy comparison.
- R7.** The certificate hash is stable under canonical serialization.
- R8.** A source-contamination scan confirms no α , Rydberg, Bohr, Lamb, electron anomaly, or measured charge data entered pre-freeze fields.
- R9.** The post-freeze activation map is declared before comparing with transition frequencies.
- R10.** The matching theorem states clearly which ordinary hydrogen quantities are recovered and which remain open.

27 How this paper changes the earlier hydrogen claims

The earlier hydrogen drafts should be rewritten in the following disciplined form.

Earlier-style claim	Paper 11 compatible rewrite
The inner-time tick is $\Delta t_r = \alpha \hbar / (m_e c^2)$.	This is a post-freeze effective tick after α is supplied; it is not used to build the alpha-free hydrogen record geometry.
Hydrogen energy levels follow from inner-time ticks.	Alpha-free temporal labels are built first; Bohr energy levels are recovered later through a matching theorem.
The Lamb shift is derived from the DTT tick.	Radiative temporal loops are a later target; numerical Lamb-shift matching is post-freeze.
All spectroscopy follows from one parameter.	Spectroscopy must be overconstrained after constants are supplied; pre-freeze hydrogen has no alpha-dependent parameter.
The electron orbits the proton in outer time.	A hydrogenic state is a stable neutral record cycle; orbit language is semiclassical imagery.

28 Toy models

Toy models are included only to test the formal machinery. They are not physical hydrogen.

28.1 Two-phase neutral oscillator

Let $F_r = \{\sigma_1, \dots, \sigma_N\}$ and define

$$\theta_p(\sigma_k) = \frac{2\pi k}{N}, \quad \theta_e(\sigma_k) = \pi - \frac{2\pi k}{N} + \epsilon_k. \quad (57)$$

Then

$$\Phi_{pe}(\sigma_k) = \pi + \epsilon_k. \quad (58)$$

If $\max_k |\epsilon_k| \rightarrow 0$, the toy model is phase-locked. Its orientation functional is

$$\mathcal{O}_H^{\text{pe}} = \sum_{k=1}^N \iota_k w_k \operatorname{sgn}(\sin(\pi + \epsilon_k)) \operatorname{Tr}(P \Pi_k P). \quad (59)$$

This shows how orientation can be computed from phase geometry before numerical spectra.

28.2 Three-cell resonance cycle

Consider a three-edge cycle with incidence signs $(+, +, +)$ and phases

$$\Phi_{pe}(e_1) = \pi - \epsilon, \quad \text{quad} \Phi_{pe}(e_2) = \pi, \quad \Phi_{pe}(e_3) = \pi + \epsilon. \quad (60)$$

The phase-opposition support contains all three cells for $|\epsilon| < \pi/2$. The winding is zero while the phase-opposition support is nontrivial. This illustrates that neutral binding and spectral winding are distinct structures.

28.3 Toy temporal Dirac matrix

A minimal finite operator is

$$D_H^{\text{temp}} = \begin{pmatrix} \mu & te^{i\phi} & 0 \\ te^{-i\phi} & -\mu & t \\ 0 & t & \mu \end{pmatrix}. \quad (61)$$

Its spectral projectors are derived from the matrix entries. If μ, t, ϕ are chosen from record data, this is alpha-free. If they are chosen to match E_n , it is not.

29 Figure and diagram plan

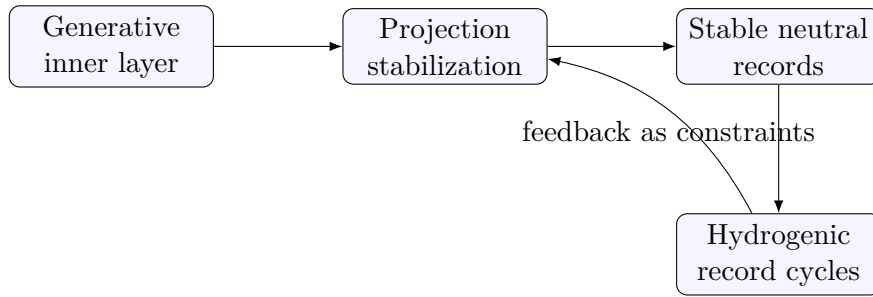


Figure 2: Planned Figure 1: alpha-free hydrogen inside the dual-time projection architecture.

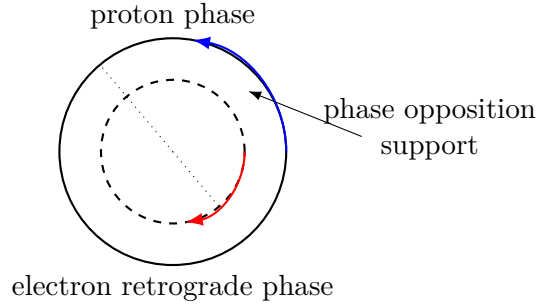


Figure 3: Planned Figure 2: alpha-free proton/electron temporal phase opposition.

Additional figure placeholders:

- regulated neutral-pair complex $\mathcal{R}_{H,r}$;
- temporal Dirac spectrum before physical-energy matching;
- source firewall and post-freeze spectroscopy activation;
- orientation descent from neutral pair to electron branch;
- finite-regulator certificate and hash pipeline.

30 Publication-level theorem spine

A final publication version of this paper should aim to establish or clearly mark the following theorem chain.

- T1. Alpha-free data construction.** Primitive DTT neutral-pair data construct $\mathcal{D}_{H,r}$ functorially.
- T2. Neutral resonance existence.** $\mathcal{D}_{H,r}$ contains a stable closed neutral resonance cycle $C_{H,r}$.
- T3. Temporal spectrum.** A temporal Dirac-type operator $D_{H,r}^{\text{temp}}$ has stable alpha-free spectral projectors.
- T4. Phase-opposition orientation.** The neutral-pair phase functional $\mathcal{O}_{H,r}^{\text{pe}}$ is regulator-stable.
- T5. Orientation descent.** $\mathcal{O}_{H,r}^{\text{pe}}$ descends to $\mathcal{O}_{e,r}^{\text{can}}$ without alpha-containing input.
- T6. Certificate freeze.** The entire alpha-free hydrogen datum can be serialized and hashed before post-freeze spectroscopy.
- T7. Post-freeze matching.** Only after upstream constants are supplied may the temporal labels be matched to ordinary hydrogenic spectroscopy.

31 Interfaces with later constants

31.1 Interface with α

The alpha interface is negative in this paper: α is not used. Later, if Papers 8–10 produce a physical electron certificate and Paper 9 proves the coupling correspondence, the resulting $\alpha_{\text{OS}}(0)$ can be inserted into Paper 12.

31.2 Interface with m_e and m_p/m_e

This paper may use labels p and e , but it does not derive their masses. The electron mass paper must define electron temporal inertia. The proton–electron mass-ratio paper must derive or calibrate the ratio before numerical isotope or reduced-mass corrections are used.

31.3 Interface with charge

Neutral compatibility is not the same as measured electric charge. A later charge-character paper must relate the primitive record character to SI charge and electromagnetic coupling.

31.4 Interface with G and cosmology

Hydrogen record stability may later become a local probe of gravitational redshift or cosmological vacuum effects, but this paper does not use gravity to construct hydrogen.

32 Referee stress tests

Objection	Response in this paper
Does this paper derive the hydrogen spectrum?	No. It derives or defines the alpha-free temporal record structure; spectroscopy is downstream.
Does it secretly use α ?	The firewall forbids $\Delta t_r = \alpha \hbar / (m_e c^2)$, Bohr/Rydberg formulas, Lamb-shift numerics, and transition frequencies before freeze.
Is the electron branch chosen from hydrogen data?	Only a target-blind orientation descent is allowed; spectra cannot choose the branch.
Is this just Bohr-Sommerfeld in new words?	No classical orbit is assumed. Record cycles are finite chains in a neutral-pair complex. Any orbit language is post-freeze semiclassical interpretation.
Can the temporal Dirac eigenvalues be fitted to observed lines?	Not in this paper. Eigenvalues must come from finite DTT record data.
Does antihydrogen enter?	Only as a future charge-conjugate orientation test; identification requires more gauge data.
What would falsify the alpha-free interface?	If the neutral-pair data cannot be constructed without alpha-containing inputs, or if orientation descent fails, hydrogen cannot support the holonomy branch.
Why write this before the spectrum paper?	To prevent circularity and to establish hydrogen as an arena rather than an input source for constants.

33 Conclusion

This manuscript establishes the first hydrogen layer of the DTT constants program. Its central claim is not that hydrogen spectroscopy has already been derived. Its claim is that a non-circular derivation program needs an alpha-free hydrogen record geometry before any Bohr, Rydberg, Lamb, fine-structure, or transition-frequency formulas are used.

The proposed hydrogen ontology is:

$$\boxed{\text{hydrogen} = \text{stable neutral proton-electron temporal record resonance.}} \quad (62)$$

The proposed safe data are:

$$\boxed{\mathcal{D}_{H,r}, C_{H,r}, D_{H,r}^{\text{temp}}, P_{k,r}, \text{Opp}_r, \mathcal{O}_{H,r}^{\text{pe}}, D_r^{\text{pe}}, h_r.} \quad (63)$$

The proposed firewall is:

$$\boxed{\Delta t_r, a_0, R_\infty, E_n, \Delta E_{\text{Lamb}}, \text{ and measured transition frequencies are post-freeze only.}} \quad (64)$$

If this alpha-free layer succeeds, hydrogen becomes the Rosetta stone of the constants program without becoming a circular source of the constants. If it fails, the hydrogen interface cannot be used to support the fine-structure derivation, and the electron certificate must proceed without it.

A Notation ledger

Symbol	Meaning
$\mathcal{G}$	Generative inner-time layer.
$\mathcal{R}$	Stable projected record layer.
Π	Projection/stabilization map.
$\mathcal{D}_{H,r}$	Regulated alpha-free hydrogen datum.
$\mathcal{R}_{p,r}, \mathcal{R}_{e,r}$	Proton and electron record complexes.
$\mathcal{R}_{H,r}$	Neutral-pair record complex.
$\Theta_{p,r}, \Theta_{e,r}$	Proton/electron compact phase cochains.
$\Phi_{pe,r}$	Pair phase $\theta_{p,r} + \theta_{e,r}$.
Opp_r	Phase-opposition support.
$C_{H,r}$	Closed neutral record cycle.
$D_{H,r}^{\text{temp}}$	Temporal Dirac-type record operator.
$P_{k,r}$	Spectral projectors of $D_{H,r}^{\text{temp}}$.
$\mathcal{O}_{H,r}^{\text{pe}}$	Neutral-pair orientation functional.
D_r^{pe}	Descent map to electron orientation data.
h_r	Hash of canonical serialization.

B Source-role ledger

Source class	Role in Paper 11	Restricted use
Projection-realism/metrology papers	Foundational record/projection architecture.	No spectroscopy imported.
Action/ $\hbar/c_\star$ papers	Upstream constants and bridge structures.	No SI numerical constants used to build hydrogen data.
Holonomy/coupling/electron certificate papers	Orientation and source-firewall discipline.	Hydrogen may not fit the electron residual.
SMM hydrogen spectral model	Temporal resonance and spectral-operator vocabulary.	No alpha-containing energy formula pre-freeze.
Hydrogen tick/spectrum notes	Post-freeze spectroscopy motivation.	$\Delta t_r = \alpha \hbar / (m_e c^2)$ quarantined.

C Finite certificate template

```
{
  "certificate_type": "alpha_free_hydrogen_temporal_resonance",
  "version": "paper11-expanded-template-v1",
  "regulator_id": "r_template",
  "uses_alpha": false,
  "physical_spectrum_claim": false,
  "primitive_data": {
    "record_complexes": ["R_p_r", "R_e_r", "R_H_r"],
    "complex_structure": "J_r",
    "phase_cochains": ["Theta_p_r", "Theta_e_r"],
```

```

    "neutral_character": "chi_r"
  },
  "cycle_data": {
    "closed_cycle": "C_H_r",
    "boundary_norm": 0,
    "phase_winding_status": "alpha_free_symbolic"
  },
  "orientation": {
    "functional": "O_pe_H_r",
    "computed_before_holonomy_phase": true,
    "computed_before_spectroscopy": true
  },
  "post_freeze_quarantine": [
    "Delta_t_r = alpha*hbar/(m_e*c^2)",
    "Bohr radius",
    "Rydberg constant",
    "Bohr energy levels",
    "Lamb shift numerics",
    "hydrogen transition frequencies"
  ]
}

```

D Validator pseudocode

```

def validate_alpha_free_hydrogen_certificate(cert):
    assert cert["certificate_type"] == "
        alpha_free_hydrogen_temporal_resonance"
    assert cert["uses_alpha"] is False
    assert cert["physical_spectrum_claim"] is False
    forbidden = ["alpha", "Rydberg", "Bohr radius", "Lamb shift"]
    for field in cert.get("pre_freeze_inputs", []):
        for token in forbidden:
            assert token.lower() not in str(field).lower()
    assert cert["orientation"]["computed_before_holonomy_phase"] is True
    assert cert["orientation"]["computed_before_spectroscopy"] is True
    return "PASS"

```

E Proof supplements

E.1 Closed-cycle additivity

If $\Theta_{p,r}$ and $\Theta_{e,r}$ are cochains on $\mathcal{R}_{H,r}$, then their sum $\Phi_{pe,r}$ is also a cochain. For a closed chain $C_{H,r}$, the total pair phase depends only on the cohomology class of $\Phi_{pe,r}$ modulo exact cochains:

$$\sum_{e \in C_{H,r}} (\Phi_{pe,r} + d\lambda)(e) = \sum_{e \in C_{H,r}} \Phi_{pe,r}(e) + \lambda(\partial C_{H,r}) = \sum_{e \in C_{H,r}} \Phi_{pe,r}(e). \quad (65)$$

Thus phase winding is a genuine cycle observable when the cycle is closed.

E.2 Orientation before phase comparison

The orientation functional (30) depends on local phase-opposition signs, incidence signs, weights, and projectors. It does not require computing a determinant Wilson phase. Therefore it can be serialized before electron holonomy comparison. This is exactly the property needed for branch support.

F Draft bibliography placeholders

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- [12] M. Haj Yousef, *Inner-Time Ticks and the Hydrogen Atom: A DTT Explanation of Energy Levels and Spectrum*, manuscript, 2025.