Equation of the Universe:

Photons

Document Class: Tier1: Derivations and Details

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Version: Rev 3.46

December 2025 EST

This document depends on
Equation of the Universe — Core Theory (Rev 3.45 or later)

§0 — Introduction

0.1 Definition

Within the EOTU framework, a photon is the emitted transport packet of a resolved curvature transition. It forms when a coupled system releases excess curvature through an allowed packet channel. The emitted packet inherits its geometry directly from the transition that produced it. Its transverse family width is denoted L_b, and its axial extent is denoted L_a. The photon wavelength is identified directly with the axial packet length,

$$\lambda_\gamma = L_a$$

Wavelength is therefore not introduced through an independent collapsed spectral constant. It is the emitted packet length itself.

0.2 Emission, Propagation, and Absorption

For any resolved emitter family, the packet is built from a discrete transition inventory determined by the state difference of the emitting system and the interaction wavelength appropriate to that family. The emitted photon is therefore a first-principles object: its packet length is produced directly from the underlying state difference and packet-construction rule, rather than imposed afterward from SI-based spectral relations. Two resolved classes are available: proton–electron adjacent-shell emission and proton–proton curvature-only exhaust through the neutral-pion channel. Both are described by the same packet grammar even though their state definitions and family widths differ.

After emission, the photon propagates only through Dormant Corridors, the phase-neutral fixed-curvature pathways that remain after Freeze-Out. During propagation, the packet preserves its emitted identity. That identity is carried primarily by its axial packet length L_a. The transverse width $L_b$defines the family residence width of the packet, but the absorber distinction is determined by the packet's axial identity.

Absorption occurs only when a receiving system already possesses an admissible receiving channel with the same packet identity. In this sense, a photon is not absorbed merely because it reaches a target. It is absorbed only when the target exposes the same transition packet that the emitter produced. A true absorber must therefore be of like-type and possess the matching receiving channel for that emitted packet.

The photon framework is therefore governed by four simple principles:

- a photon is created only by an admissible state transition
- its wavelength is the axial packet length L_a
- it propagates without changing identity through dormant corridors
- it is absorbed only by a matching receiving channel of the same packet type

In this form, the photon is a transported transition packet whose geometry, propagation, and absorption all follow directly from the same lattice grammar used elsewhere in EOTU.

0.3 Electron

Electron Reach $R_{\text{eff},e}$ $N_{\text{E+ZZZ}} = 4$

$$k_{\text{CPP}}\ (UUD - ZZZ) = 4^2 = 16$$

$$R_{\text{eff}}\ (k) = (51\ k_{\text{CPP}})\ L_0 = 51(16)\ L_0 = 816\ L_0$$

The composite core for baryonic then becomes $k_{\text{CPP}}\ (E - ZZZ) = 4^2 = 16$:

$$\text{R\_eff, baryonic} = \frac{8}{51} 816\ L_0 = 128\ L_0$$

Electron halo wavelength: $\lambda_e = 816\ L_0$

0.4 Proton

Proton Reach $R_{\text{eff,p}}$ $N_{\text{UUD+ZZZ}} = 6$

$$k_{\text{CPP}}\ (UUD - ZZZ) = 6^2 = 36$$

$$R_{\text{eff}}\ (k) = (51\ k_{\text{CPP}})\ L_0 = 51(36)\ L_0 = 1836\ L_0$$

The composite core for baryonic then becomes:

$$\text{R\_eff, baryonic} = \frac{8}{51} 1836\ L_0 = 288\ L_0$$

Proton halo wavelength: $\lambda_p = 1836\ L_0$

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§1 — Properties

This document assumes the following EOTU terms and quantities are already fixed.

- L_0= fundamental lattice length unit
- λ_{pe}= proton-electron interaction wavelength
- λ_{pp}= proton-proton interaction wavelength
- λ_k= fixed King wavelength
- τ_0= intrinsic update interval

$$\lambda_{pe} = 1{,}498{,}176\, L_0, \qquad \lambda_{pp} = 3{,}370{,}896\ \ L_0, \qquad \frac{\lambda_p}{\lambda_e} = 2.25$$

A Dormant Corridor is the phase-neutral fixed-curvature pathway that permits photon transport after Freeze-Out.

A like-type receiver is a receiving system built from the same transition grammar as the emitter and exposing the reciprocal open channel for the same packet type.

For the worked protium example, the values are

$$S_1 = 29{,}447{,}706\, L_0,\ \ S_2 = 105{,}124{,}088\, L_0,\ \ \lambda_{pe} = 1{,}498{,}176\, L_0$$

For the worked proton–proton neutral-pion example, the values are

$$S_1 = 288\, L_0,\ \ S_2 = 298\, L_0,\ \ \lambda_{pp} = 3{,}370{,}896\, L_0$$

1.1 Ground-State Anchor

The protium system possesses a single ground-state coupling depth E_1. This value represents the **measured-channel energy required to break the electron–proton corridor coupling**.

The energy–curvature relation

$$E_\gamma = \Gamma(\Delta\mu)^2, \qquad \Gamma = 1\ \text{eV}$$

Using $E_\gamma = \Gamma(\Delta\mu)^2$, the curvature ladder maps directly to the energy ladder.

The hydrogen derivation in the hydrogen document yields:

$$E_1 \approx 13.6034\ \text{eV}$$

Measured ionization energy:

$$E_{\text{measured}} \approx 13.5984\ \text{eV}$$

Agreement is within approximately **0.04%**, establishing the ground-state energy as a valid normalization anchor.

Stable electron–proton separations occur at discrete closure-compatible eigenmodes indexed by integer n. The energy depth of each eigenmode follows:

$$\boxed{E_n = \frac{E_1}{n^2}}$$

where

- $n = 1$ is the ground state
- $n = 2,3,4, \ldots$are higher corridor eigenmodes

This produces the complete hydrogen energy ladder.

1.2 State Identification

The allowed hydrogen eigenmodes arise from phase-closure compatibility between these two corridor wavelengths. Each eigenmode state is identified by the closure signature

$$\boxed{S_n = (n, \Delta\phi_n^{(p)}, \Delta\phi_n^{(e)})}$$

where

- n is the corridor eigenmode index
- $\Delta\phi_n^{(p)}$ is the proton closure class
- $\Delta\phi_n^{(e)}$ is the electron closure class

The integer index n must remain part of the state definition because closure-class signatures alone can repeat for different eigenmodes.

1.3 Step-Locked Motion: One Hop per King Cycle

Photon propagation is synchronized to the King cycle. Each hop across one Dormant Cell occurs exactly once per τ_0 interval. Because Dormant Cells are separated by the fixed King wavelength λ_k, this yields the fundamental propagation law:

$$c = \lambda_k / \tau_0 = 1.667800087\text{E+26 } L_0/\text{s}$$

This defines the photon's speed as a **geometric ratio**, not a dynamical variable.

1.4 Photon Packet Construction

In EOTU, a photon is a directed emitted packet whose wavelength is the axial packet length of the emitted structure itself. The photon is not introduced through a separate spectral constant, and it is not modeled as an isotropic sphere. It is an elongated packet constructed directly from the transition geometry of the emitting system.

For an emitted photon packet, define:

$$L_b = \text{family transverse width}, L_a = \text{axial packet length}$$

and identify the photon wavelength directly as

$$\lambda_\gamma \equiv L_a$$

Thus wavelength is not a secondary converted observable. It is the emitted packet length itself. The packet is built from a discrete transition inventory N_γ. For the elongated packet construction, the axial length is

$$L_a = \frac{6N_\gamma}{\pi L_b}$$

where L_b is the admissible family width for the emitting transition class and N_γ is the discrete transition inventory generated by the state span of the emitter. The packet grammar is universal, while the family definition is interaction-specific:

$$\Delta S \to N_\gamma \to L_a \to \lambda_\gamma$$

For proton–electron adjacent-shell families, the transition inventory is generated from the shell span using λ_{pe}. For the first adjacent-shell family,

$$L_b = 64 \cdot 51 - 61 = 3203$$

and

$$N_\gamma = \lambda_{pe}(S_2 - S_1)$$

so that

$$\lambda_\gamma = L_a = \frac{6\lambda_{pe}(S_2 - S_1)}{\pi \cdot 3203}$$

For proton–proton curvature-only exhaust through the neutral-pion channel, the same packet law remains valid but the family definition changes. In Appendix D, the event is represented by a shared proton-overlap state difference and a proton–proton family width:

$$\Delta S_{pp} = 5, \qquad L_{b,pp} = 6324, \qquad N_{\gamma,pp} = \lambda_{pp}\Delta S_{pp}$$

for the single π^0-scale packet, and

$$\Delta S_{pp} = 10, \qquad L_{b,pp} = 6324, \qquad N_{\gamma,pp} = \lambda_{pp}\Delta S_{pp}$$

For the observed two-photon decay scale. Thus the same axial packet law resolves both one-electron emission and proton–proton neutral-pion production without introducing a new packet formula.

1.5 Photon Interaction with Coupled Regions

In the EOTU framework, a photon does not interact with a target merely because it arrives there. Interaction occurs only when the target already possesses an admissible receiving channel whose emitted packet identity matches that of the incoming photon. Ordinary absorption is therefore not generic contact with matter. It is channel-specific packet acceptance.

Stable composite Regions such as atoms, ions, molecules, and nuclei retain their intrinsic internal closure unless an incoming packet matches one of their admissible transition channels. Thus photon interaction is governed by the receiving structure, not by the mere presence of the packet.

For an emitted photon, the operative packet identity is its axial length:

$$\lambda_\gamma \equiv L_a$$

True absorption occurs only when the incoming packet length matches the axial packet length of an admissible receiving channel:

$$\boxed{\text{Absorb} \iff L_a^{(\gamma)} = L_a^{(\text{receiver channel})}}$$

and otherwise the packet is not absorbed:

$$\boxed{\text{Reject} \iff L_a^{(\gamma)} \neq L_a^{(\text{receiver channel})}}$$

This means that absorption is not a broad percentage similarity condition. The incoming packet must be the same packet type as the receiving transition. Close wavelength agreement is not enough. The receiving system must expose the same axial packet identity.

A true absorber must therefore be of like-type and must possess the matching receiving channel for that emitted packet. In this way, protium absorbs a matching protium packet, deuterium absorbs a matching deuterium packet, and tritium absorbs a matching tritium packet. Similar families may remain close in wavelength while still failing true packet acceptance because their axial packet identities are distinct.

The interaction rule is therefore:

$$\boxed{\gamma + X \to X^{*} \text{only if} L_a^{(\gamma)} = L_a^{(X, \text{open channel})}}$$

where X^{*} denotes the target after completing the admissible receiving transition.

If no such channel exists, no true absorption occurs. The packet may continue, be redirected by boundary geometry, or fail to couple, but it is not accepted as a resonant state-changing photon by that target.

Thus photon absorption in EOTU is a packet-identity selection law. The emitter defines the packet. Propagation preserves it. The receiver either has the same channel or it does not.

§2 — Emission Mechanics

Photon emission in the EOTU framework is the formation of an emitted curvature packet by an admissible transition of a coupled Region system. The photon is packet-resolved because its inventory is built from the transition span. When the internal packet states fill coherently, the emitted photon carries a smooth curvature envelope across its axial length.

A coupled system emits a photon when it passes from one admissible state to another and the transition produces a detached packet through the corresponding shell-span geometry.

2.1 Trigger Condition for Emission

A photon may be emitted only when a coupled Region system possesses at least two admissible states and undergoes a permitted transition between them.

For an emitting transition,

$$S_i \to S_j$$

the transition span determines the packet construction rule. In the general form,

$$\Delta S = S_i - S_j$$

and this state span generates the packet inventory

$$N_\gamma = \lambda_{\text{int}}\, \Delta S$$

where $\lambda_{\text{int}}$is the interaction wavelength appropriate to the emitting family. The emitted packet length is then

$$L_a = \frac{6N_\gamma}{\pi L_b}$$

with the emitted wavelength identified directly as

$$\lambda_\gamma \equiv L_a$$

Thus emission is the direct chain

$$S_i \to S_j \to \Delta S \to N_\gamma \to L_a \to \gamma$$

This is the first-order packet-emission law.

For proton–electron adjacent-shell emission, $\lambda_{\text{int}} = \lambda_{pe}$ and the state span is an atomic shell difference. For proton–proton curvature-only exhaust, $\lambda_{\text{int}} = \lambda_{pp}$ and the state span is the admissible overlap-state difference of the collision event.

The 21 cm line is treated as an admissible internal state of the electron within ground-state protium, not as a proton-electron shell transition. In this state, the electron remains a fully closed EZZZ structure, but the electron-side Zemach envelope occupies a distinct resolved configuration relative to the proton. This resolved configuration perturbs the ordinary proton-electron loading relation, so the emitted packet is no longer governed solely by the primary shell-transition wavelength built from $\lambda_{pe} = 1{,}498{,}176$. Instead, the electron-dominated resolved state produces a secondary packet buildup whose wavelength falls in the 21 cm class.

$$\Delta S_{e,\text{res}} \rightarrow N_\gamma \rightarrow L_a \rightarrow \lambda_\gamma$$

where $\Delta S_{e,\text{res}}$ denotes the admissible resolved-state span of the closed electron triad within ground-state protium.

When two electrons collide, the interaction resolves through the combined electron wavelength scale. With the intrinsic electron wavelength already established as

$$\lambda_e = 816\, L_0$$

the two-electron collision wavelength is

$$\lambda_{ee,C} = 2\lambda_e^2$$

Substituting the locked electron value gives

$$\lambda_{ee,C} = 2(816)^2 = 1{,}331{,}712\, L_0$$

Using the locked lattice bridge

$$1\ \text{Å} = 55{,}618{,}373.16\, L_0$$

this becomes

$$\lambda_{ee,C} = \frac{1{,}331{,}712}{55{,}618{,}373.16} = 0.0239437\ \text{Å}$$

This places the two-electron collision wavelength directly in the Compton-scale range with no new constants, no fitted terms, and no added construction. The result follows directly from the locked intrinsic electron wavelength and the locked lattice bridge. The Compton-scale outcome is therefore not imposed from outside the framework; it emerges naturally as the quadratic self-interaction scale of the electron, with the factor of 2 arising from the two-electron collision itself.

2.2 Discrete Emission Rule

Each emission event is discrete and complete. One admissible transition produces one emitted packet. If additional photons are emitted, they arise from additional admissible transitions or from an admissible multi-photon resolution channel.

The discreteness belongs to the transition event and packet identity. The transported curvature envelope is set by coherent packet filling across the emitted axial length:

$$L_a = \lambda_\gamma$$

When adjacent packet states fill at the same rate and remain phase-compatible, the emitted photon carries a smooth curvature envelope while retaining its packet-resolved construction.

Thus repeated emission occurs as a sequence of distinct transition events:

$$S_i \to S_j, S_j \to S_k, S_k \to S_m, \ldots$$

Each emitted photon is tied to its own specific transition grammar.

2.3 Packet Formation

The emitted packet inherits its geometry from the transition that formed it. Its transverse family width is set by the applicable family rule L_b, while its axial extent $L_a$is produced by the packet inventory generated from the shell-span.

For the first adjacent-shell hydrogenic family,

$$L_b = 64 \cdot 51 - 61 = 3203$$

so that

$$\lambda_\gamma = L_a = \frac{6N_\gamma}{\pi \cdot 3203}$$

In this form, the emitted wavelength is not imposed by an external spectral constant. It is constructed directly from the transition geometry of the emitter.

2.4 Multiple Emissions

A system may emit more than one photon during relaxation, but only through admissible packet-resolution structure. In the simplest case, repeated emission occurs through successive permitted transitions:

$$S_i \to S_j, S_j \to S_k, S_k \to S_m, \ldots$$

Each emitted photon is therefore tied to its own specific transition grammar. However, the framework also admits events whose observed outcome is a multi-photon resolution of a single collision packet class. The worked neutral-pion channel in Appendix D provides the first resolved example:

$$p + p \to p + p + \pi^0 \to p + p + 2\gamma$$

$$\lambda_{pp} = 1836^2 = 3{,}370{,}896\ L_0$$

In that case, the proton–proton interaction first defines the event packet scale, while the observed laboratory outcome is a two-photon final state. Thus the packet grammar remains unchanged, but the event may resolve as either a single packet scale or an observed multi-photon outcome depending on the admissible channel. This provides the first bridge from single-emission events to multiple-photon events within the same EOTU packet law.

2.5 Summary of Emission Mechanics

Photon emission is governed by a simple set of rules:

- emission occurs only through an admissible transition
- the shell-span of that transition determines the packet inventory
- the packet inventory determines the axial packet length L_a
- the emitted wavelength is the packet length itself
- each emission is discrete and transition-specific
- coherent packet filling produces a smooth transported curvature envelope
- repeated emissions occur as separate transition events or admissible multi-photon resolution channels

In this way, the emitted photon is a first-principles packet formed directly from the transition geometry of the emitting system.

Appendix A and Appendix B treat proton–electron one-electron emission families. Appendix D treats proton–proton curvature-only exhaust through the neutral-pion channel and its observed two-photon outcome. Together they show that the same packet law applies across distinct interaction classes without introducing a new emitted-packet formula.

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§3 — Propagation Mechanics

Photon propagation in the Emerging Oscillating Fabric Universe (EOTU) is governed entirely by the fixed geometry of Dormant Corridors and the universal timing of the King cycle. This section formalizes the propagation rules that constrain every photon created after Freeze-Out.

3.1 Corridor-Constrained Motion

After emission, a photon is bound to the Dormant Corridor network. The photon propagates as a discrete emitted packet whose operative identity is its axial packet length L_a. Only Dormant Corridors — phase-neutral, fixed-curvature pathways — permit photon transport after Freeze-Out.

3.2 Single-Hop Update Rule

Photon propagation is discretized. Each hop from one Dormant Cell to the next occurs once per τ_0, with spatial displacement fixed by λ_k:

$$(x_{n+1}, t_{n+1}) = (x_n + \lambda_k,\, t_n + \tau_0)$$

This defines the packet transport rule. Packet identity is preserved during propagation.

The emitted packet is filled across its axial length L_a. When adjacent packet states remain phase-compatible and fill at the same rate, the transported photon forms a smooth curvature envelope.

The allowed packet spacing is governed by the dormant-cell update structure:

$$\Delta s_{\text{packet}} = N_{\text{packet}} L_0$$

where:

$$N_{\text{packet}} \in \mathbb{Z}^+$$

The continuum limit occurs when packet spacing is smaller than the resolving interval of the observation:

$$\Delta s_{\text{packet}} \ll \Delta s_{\text{obs}}$$

with:

$$\Delta s_{\text{obs}} = c_{L0}\, \Delta t_{\text{obs}}$$

Thus, photon curvature remains packet-resolved in construction and envelope-smooth under coherent packet filling.

3.3 No Acceleration, No Deceleration, No Deviation

During free propagation, the photon does not self-evolve into a different packet class. Its axial packet identity remains fixed unless and until interaction occurs with other curvatures. Thus any selective interaction behavior belongs to emission and absorption, not to in-flight transformation.

3.4 Geometric Dilution via Corridor Topology

For an isotropic emitter, photon transport proceeds through the network of allowed Dormant-Corridor routes embedded in the surrounding region geometry. As distance from the emission site increases, the number of accessible corridor routes intersecting a given shell grows with shell area. Consequently, the fraction of emitted packets intersecting a fixed detector area decreases with distance.

This produces geometric dilution of received photon rate without requiring in-flight photon loss, waveform expansion, or changes to packet identity. The packet remains unchanged in propagation; dilution arises solely from corridor-route geometry.

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§4 — Absorption Mechanics

Photon absorption in the EOTU framework is the acceptance of an incoming emitted packet by an admissible receiving channel of a coupled Region system. The photon does not alter a target merely by arriving there. It is absorbed only if the target already possesses a receiving channel whose packet identity matches the incoming packet.

The operative packet identity is the photon axial length:

$$\lambda_\gamma \equiv L_a$$

Thus strong absorption is governed by exact packet identity, not by approximate wavelength similarity and not by generic contact with curvature alone.

4.1 Absorption Trigger Condition

A photon may be absorbed only when it reaches a target that exposes an admissible open receiving channel with the same axial packet identity as the incoming photon.

$$\boxed{\text{Absorb} \iff L_a^{(\gamma)} = L_a^{(\text{receiver channel})}}$$

and otherwise

$$\boxed{\text{Reject} \iff L_a^{(\gamma)} \neq L_a^{(\text{receiver channel})}}$$

This is the present first-order acceptance law.

4.2 Channel-Specific Acceptance

The receiving structure must already contain the channel that can accept the packet. The photon does not create the receiving channel it is a resonant state-changing packet.

Thus a true absorber must be of like-type and possess the matching receiving channel for that emitted packet. Similar packet families may remain close in measured wavelength while still failing absorption because their axial packet identities remain distinct.

In this form:

- Same element in same state accepts a matching packet
- protium accepts a matching protium packet
- deuterium accepts a matching deuterium packet
- tritium accepts a matching tritium packet

but cross-family or cross-isotope near-matches are not true absorbers unless the packet identity is the same.

The 21 cm line is treated as an admissible internal state of the electron within ground-state protium, not as a proton-electron shell transition. In this state, the electron remains a fully closed EZZZ structure, but the electron-side Zemach envelope enters a distinct resolved configuration relative to the proton. A matching absorber must therefore be ground-state protium capable of exposing the same electron-resolved receiving channel. The packet is not accepted by ordinary shell resonance alone, but only by the reciprocal internal resolved state of like-type protium.

4.3 State Change at the Absorber

When the matching condition is satisfied, the target as a resonant state-changing photon, completes the corresponding admissible receiving transition. The photon then ceases to exist as an independent propagated object because its packet has been fully incorporated into the receiving channel.

$$\gamma + X \to X^*$$

where X^* is the target after completing the receiving transition.

Thus absorption is not a partial weakening of the packet. It is packet acceptance into a permitted state change.

4.4 Rejection and Non-Absorption

If no matching receiving channel exists, no true absorption occurs.

$$\gamma + X \nrightarrow X^* \text{ if } L_a^{(\gamma)} \neq L_a^{(X,\text{open channel})}$$

In that case the packet is not accepted by the target as a resonant state-changing photon. It may continue through the dormant corridor, be redirected by boundary geometry, or fail to couple locally, but it is not absorbed.

4.5 Like-Type Absorption

For a like-type emitter and receiver, the emitted packet and receiving channel are constructed from the same transition grammar. Absorption then occurs only if the receiver exposes the reciprocal open channel with the same axial packet identity.

Thus the complete like-type rule is:

$$\boxed{\text{Like-type absorption} \iff L_a^{(\text{emitted packet})} = L_a^{(\text{receiver open channel})}}$$

This is the simplest form of true resonant absorption in the present photon framework.

4.6 Summary Rule

The absorption law is therefore:

$$\boxed{\gamma \text{ is absorbed only by a target whose open receiving channel has the same } L_a}$$

Emission defines the packet. Propagation preserves it. Absorption occurs only by exact packet acceptance.

Appendix A- Photon Emission, Propagation, and Absorption

This appendix gives the first complete worked photon cycle for a like-type protium channel in EOTU Framework. A photon is emitted when a shell transition generates a discrete elongated packet whose wavelength is the axial packet length of the packet itself. The packet is constructed directly from the shell-span geometry of the emitting transition, propagates through the dormant corridor without changing identity, and is absorbed only by a receiver that exposes the same packet through an admissible open channel.

The full like-type protium cycle is therefore

$$\text{Protium } (S_2 \to S_1) \ \to \ \gamma \ \to \ \text{free propagation} \ \to \ \text{Protium } (S_1 \to S_2)$$

where the receiver must expose the reciprocal open channel of the same packet type.

1. Starting constants

For protium, the relevant shell values are

$$S_1 = 29{,}447{,}706\, L_0, \qquad S_2 = 105{,}124{,}088\, L_0$$

and the proton-electron interaction wavelength is

$$\lambda_{pe} = 1{,}498{,}176\, L_0$$

For the first adjacent-shell emitted family, the transverse family width is

$$L_b = 64 \cdot 51 - 61 = 3203$$

2. Shell-span of the emitting transition

For the protium transition from $S_2$to S_1, the shell-span is

$$\Delta S = S_2 - S_1$$

so that

$$\Delta S = 75{,}676{,}382\, L_0$$

This is the first-principles transition span that drives packet formation.

3. Packet inventory

The emitted packet is built from the shell-span through the discrete inventory rule

$$N_\gamma = \lambda_{pe}(S_2 - S_1)$$

Thus for protium $S_2 \to S_1$,

$$N_\gamma = 1{,}498{,}176 \cdot 75{,}676{,}382, \qquad N_\gamma = 113{,}376{,}539{,}502{,}460$$

So the emitted packet inventory is determined directly from the shell geometry and the interaction wavelength.

4. Axial packet length

In the present elongated-packet construction, the photon wavelength is the axial packet length of the emitted packet itself. Define

$$\lambda_\gamma \equiv L_a$$

with axial length given by

$$L_a = \frac{6N_\gamma}{\pi L_b}$$

For the protium $S_2 \to S_1$ packet the emitted photon wavelength is,

$$\lambda_\gamma \equiv L_a = \frac{6(113{,}376{,}539{,}502{,}460)}{\pi \cdot 3203} \approx 67{,}603{,}259{,}540.9432\, L_0$$

This is the packet wavelength produced directly from the protium shell transition.

5. Packet identity

The emitted packet is therefore determined by the chain

$$(S_2 - S_1) \;\to\; N_\gamma \;\to\; L_a$$

with the wavelength identified directly as

$$\lambda_\gamma \equiv L_a$$

This axial packet length is the primary packet identity carried by the photon.

6. Propagation through the dormant corridor

After emission, the packet propagates freely through the dormant corridor network. In this phase, the corridor transports the packet but does not redefine it. The emitted packet length remains unchanged during propagation:

$$\gamma_{\text{emit}} = \gamma_{\text{prop}}$$

So the packet that arrives at a receiver is the same packet that was formed at emission.

7. Like-type absorption by protium

A like-type protium receiver has the same shell grammar as the emitter. However, the photon is absorbed only if the receiver exposes the reciprocal open channel with the same packet identity.

For the reciprocal protium channel $S_1 \to S_2$, true absorption requires

$$L_a^{(\gamma)} = L_a^{(\text{receiver channel})}$$

So the first-order acceptance rule is

$$\boxed{\text{Absorb} \iff L_a^{(\gamma)} = L_a^{(\text{receiver channel})}}$$

and otherwise

$$\boxed{\text{Reject} \iff L_a^{(\gamma)} \neq L_a^{(\text{receiver channel})}}$$

Thus the photon is not absorbed merely because it reaches another protium. It is absorbed only when that protium is in the state that exposes the reciprocal receiving channel for that same packet.

8. Worked protium cycle

The complete worked protium cycle is therefore

$$S_2 \to S_1 \;\to\; \Delta S = 75{,}676{,}382 \;\to\; N_\gamma = 113{,}376{,}539{,}502{,}460 \;\to$$

$$L_a \approx 67{,}603{,}259{,}541\, L_0 \;\to\; \gamma \;\to\; \text{free propagation} \;\to\; L_a^{(\gamma)} = L_a^{(\text{receiver channel})} \;\to\; S_1 \to S_2$$

with the core packet law

$$\boxed{\lambda_\gamma = L_a = \frac{6\,\lambda_{pe}(S_2 - S_1)}{\pi L_b}}$$

and for the first adjacent-shell family

$$\boxed{\lambda_\gamma = \frac{6\,\lambda_{pe}(S_2 - S_1)}{\pi \cdot 3203}}$$

9. Interpretation

This worked case shows the complete first-order photon cycle in present form:

- the emitter shell-span determines the packet inventory
- the packet inventory determines the axial packet length
- the axial packet length is the photon wavelength
- propagation preserves packet identity
- only the matching reciprocal like-type channel is a true absorber

So in the present photon framework, emission, propagation, and like-type absorption all reduce to the same packet grammar.

Appendix B — Calculating Wavelength for Element Z

This appendix extends the photon packet construction from the worked protium case to the full hydrogenic one-electron sequence presently resolved in the EOTU framework. Therefore, the protium result is not a special isolated case; it is the $Z = 1$ member of a broader family rule applying to one-electron emitters.

The hydrogen shell anchors are taken as the family generators,

$$S_1^{(H)}, S_2^{(H)}, S_3^{(H)}, S_4^{(H)}.$$

For the hydrogenic one-electron sequence, the shell radii scale with atomic number as

$$S_n(Z) = \frac{S_n^{(H)}}{Z}.$$

Therefore the shell spans scale in the same way:

$$\Delta S_{m\to n}(Z) = \frac{S_m^{(H)} - S_n^{(H)}}{Z}.$$

The emitted photon wavelength remains identified directly with the axial packet length,

$$\lambda_\gamma \equiv L_a, L_a = \frac{6N_\gamma}{\pi L_b}.$$

For one-electron hydrogenic emitters, the packet inventory inherits the shell-span reduction together with the emitting charge-class reduction, so that within a fixed transition family the emitted packet length scales as

$$\lambda_{\gamma,\mathrm{family}}(Z) \propto \frac{1}{Z^2}.$$

Accordingly, the present resolved adjacent-shell families are as follows.

1. First adjacent-shell family

$$S_2 \to S_1$$

For this family, the transverse packet width is

$$L_{b,21} = 64 \cdot 51 - 61 = 3203.$$

The packet inventory is

$$N_{\gamma,21}(Z) = \lambda_{pe} \frac{S_2^{(H)} - S_1^{(H)}}{Z^2},$$

so the emitted wavelength is

$$\lambda_{\gamma,21}(Z) = \frac{6\lambda_{pe}\left(S_2^{(H)} - S_1^{(H)}\right)}{\pi \cdot 3203\ Z^2}.$$

Thus the protium $S_2 \rightarrow S_1$packet is simply the $Z = 1$member of this family.

2. Second adjacent-shell family

$$S_3 \rightarrow S_2$$

For this family, the transverse packet width is

$$L_{b,32} = 2(64 \cdot 51 - 72) = 6384.$$

The packet inventory is

$$N_{\gamma,32}(Z) = 51\,\lambda_{pe}\frac{S_3^{(H)} - S_2^{(H)}}{Z^2},$$

so the emitted wavelength is

$$\lambda_{\gamma,32}(Z) = \frac{6 \cdot 51\,\lambda_{pe}\left(S_3^{(H)} - S_2^{(H)}\right)}{\pi \cdot 6384\ Z^2}.$$

3. Third adjacent-shell family

$$S_4 \rightarrow S_3$$

For this family, the transverse packet width is

$$L_{b,43} = 3(64 \cdot 51 - 234) = 9090.$$

The packet inventory is

$$N_{\gamma,43}(Z) = 102\,\lambda_{pe}\frac{S_4^{(H)} - S_3^{(H)}}{Z^2},$$

so the emitted wavelength is

$$\lambda_{\gamma,43}(Z) = \frac{6 \cdot 102\,\lambda_{pe}\left(S_4^{(H)} - S_3^{(H)}\right)}{\pi \cdot 9090\ Z^2}.$$

4. Family interpretation

The importance of this rule is that it extends the photon framework beyond a single protium example without changing the underlying packet grammar. The structure remains the same in every case:

$$\text{shell family} \rightarrow \Delta S(Z) \rightarrow N_\gamma(Z) \rightarrow L_a(Z) \rightarrow \lambda_\gamma(Z).$$

The family rule fixes the admissible transverse width $L_b$and any family multiplier. The emitting charge index Zthen fixes the member of that family through the $1/Z^2$scaling. In this way, all currently resolved one-electron emitters through $Z = 10$are described by the same packet construction law.

5. Relation to the worked protium case

Appendix A gives the explicit worked case for protium. That result remains unchanged. The purpose of the present appendix is to show that the protium packet is the base member of a broader hydrogenic one-electron family. Thus Appendix A supplies the concrete $Z = 1$example, while Appendix B supplies the generalized Z-rule for the corresponding families.

Appendix D – Neutral Pion from p + p collision

A proton beam on a stationary proton can produce a neutral pion while leaving **two protons in the final state** (identity preserved). This is an **inelastic** channel (new particle created), but baryons remain protons.

Annotated: $p + p \to p + p + \pi^0 \to p + p + 2\gamma$

$$\lambda_{pp} = 1836^2 = 3{,}370{,}896\ L_0$$

The "curvature-only packet" (invariant)

The neutral pion has fixed rest-mass budget:

$$m_{\pi^0} c^2 \approx 134.98\ \mathrm{MeV}$$

and decays overwhelmingly to:

$$\pi^0 \to \gamma + \gamma$$

In the π^0rest frame, each photon carries:

$$E_\gamma = \frac{m_{\pi^0} c^2}{2} \approx 67.5\ \mathrm{MeV}$$

Timescale (the entire existence of the π^0 state)

Mean lifetime:

$$\tau(\pi^0) \approx 8.43 \times 10^{-17}\ \mathrm{s}\ \text{(PDG lifetime/width compilation).}$$

In your King-cycle units (using your $\tau_0$value from EOTU):

$$N_K = \frac{\tau(\pi^0)}{\tau_0} \approx 3.16 \times 10^{15}\ \text{cycles}$$

So the **curvature-only resolution completes in ~**3×10^{15} King cycles.

Outcome summary (EOTU language): curvature overload → **forced EM exhaust** → **2γ**, no neutrinos, no leptons, no weak chain.

Threshold (lab frame, fixed target)

The **threshold kinetic energy** for $p + p \to p + \ p + \pi^0$ in the lab (one proton at rest) is about **280 MeV** (the "extra" above 135 MeV is momentum-conservation overhead).

A standard closed-form expression for a reaction $1 + 2 \to a + b + c$ with target 2 at rest is:

$$E_{1,\mathrm{thr}} = \frac{(m_a + m_b + m_c)^2 - (m_1^2 + m_2^2)}{2m_2}\ c^2,\ \ T_{\mathrm{thr}} = E_{1,\mathrm{thr}} - m_1 c^2$$

Under the proton-overlap interpretation, keeping the same proton geometric shape but elevating the closure level gives:

$$r^{\star}_{\text{charge}} \approx 490.91\,L_0, \qquad r^{\star}_{\text{mass}} \approx 500.21\,L_0, \qquad r^{\star}_{Z} \approx 609.30\,L_0,$$

$$R^{\star}_{\text{eff,bary}} \approx 308.02\,L_0, \qquad R^{\star}_{\text{eff,halo}} \approx 1963.63\,L_0.$$

If instead you split the pion rest-mass budget **symmetrically across the two protons**,

$$E^{\star} = 938.2446895 + 67.4884 = 1005.7330895 \text{ MeV}, \qquad m^{\star}_{f} = 31713.2952, \alpha = 1.03534076,$$

which gives the excited values:

$$r^{\star}_{\text{charge}} \approx 475.22\,L_0, \qquad r^{\star}_{\text{mass}} \approx 484.22\,L_0, \qquad r^{\star}_{Z} \approx 589.83\,L_0,$$

$$R^{\star}_{\text{eff,bary}} \approx 298.18\,L_0, \qquad R^{\star}_{\text{eff,halo}} \approx 1900.89\,L_0.$$

Appendix F - Hyperfine splitting (21 cm line)

Emitter family: neutral hydrogen

- **Channel:** ground-state hyperfine transition
- **Observed frequency:** 1420.405751786 MHz
- **Observed wavelength:** 21.106114 cm = 2.1106114×10^{9}Å
- **Observed photon energy:** 5.874326×10^{-6}eV
- **Class note:** not one-electron shell transition; separate hydrogen photon family

From conventional QM.

Several high-precision hydrogen measurements scale directly with $|\psi(0)|^2$: The hydrogen 1s hyperfine splitting is proportional to:

$$|\psi(0)|^2$$

because the magnetic interaction depends on the electron being *at* the proton. If your model predicts the wrong contact scaling, it will not reproduce the 1420 MHz line.

If by "what we are looking for" you mean the $|\psi(0)|^2$**-type contact density for hydrogen ground state (1s)**, the standard reference value is:

$$|\psi_{1s}(0)|^2 = \frac{1}{\pi a_0^3}$$

Using the 2022 CODATA Bohr radius $a_0 = 5.29177210544 \times 10^{-11}$ m.

Numerical value (SI)

$$|\psi_{1s}(0)|^2 = \frac{1}{\pi(5.29177210544 \times 10^{-11}\ \mathrm{m})^3} \approx 2.148061589 \times 10^{30}\ \mathrm{m}^{-3}$$

(The 1s wavefunction form that implies this is $\psi_{1s}(r) = \frac{1}{\sqrt{\pi a_0^3}} e^{-r/a_0}$, so $|\psi(0)|^2 = 1/(\pi a_0^3).$)

Same quantity in your lattice-cell length unit

Since you locked:

$$a_0/\lambda_k \approx 1.88396 \times 10^{9}\ \text{cells}$$

then, in per cell^3 units:

$$|\psi_{1s}(0)|^2_{\text{cells}} = \frac{1}{\pi(1.88396 \times 10^{9})^3} \approx 4.76030845 \times 10^{-29}\ \text{cell}^{-3}$$

If you meant a *different* "measured value" (e.g., the hyperfine splitting frequency, Lamb shift, or proton-size contribution), tell me which observable and I'll pull the corresponding experimental number.

according to NIST's 21 cm hydrogen line frequency is

$$\boxed{\nu = 1420.4057517667\ \text{MHz}}$$

The electron

The 21 cm photon energy is tiny compared with the electron rest energy, so the fractional increase is only

$$\frac{E_{21}}{E_e} \approx 1.1496 \times 10^{-11}$$

and the corresponding scaling factor is

$$\alpha_e \approx 1.0000000000057478$$

That means the globally excited closed-electron radii would be:

$$R_{\text{mass}}^{\backslash *} = 51\alpha_e \approx 51.000000000293\ L_0$$

$$R_{\text{eff,bary}}^{\backslash *} = 128\alpha_e \approx 128.000000000736\ L_0$$

$$r_{\text{Zemach}}^{\backslash *} = 153\alpha_e \approx 153.000000000879\ L_0$$

$$R_{\text{eff,halo}}^{\backslash *} = 816\alpha_e \approx 816.000000004690\ L_0$$

So the direct result is:

Appendix G - Electron-positron annihilation: 2 × 511 keV

Appendix G - Electron-positron annihilation: 2 × 511 keV

Appendix H - Fe-57 Mössbauer 14.4 keV

A narrow nuclear gamma benchmark