

Equation of the Universe

Neutron

Document Class: Tier 1: Details and Derivations

Author: Glenn R. King

Independent Researcher, Akron, Ohio, USA

Email: Gking@DMsHelper.com

Version: Rev 3.47

December 2025 EST

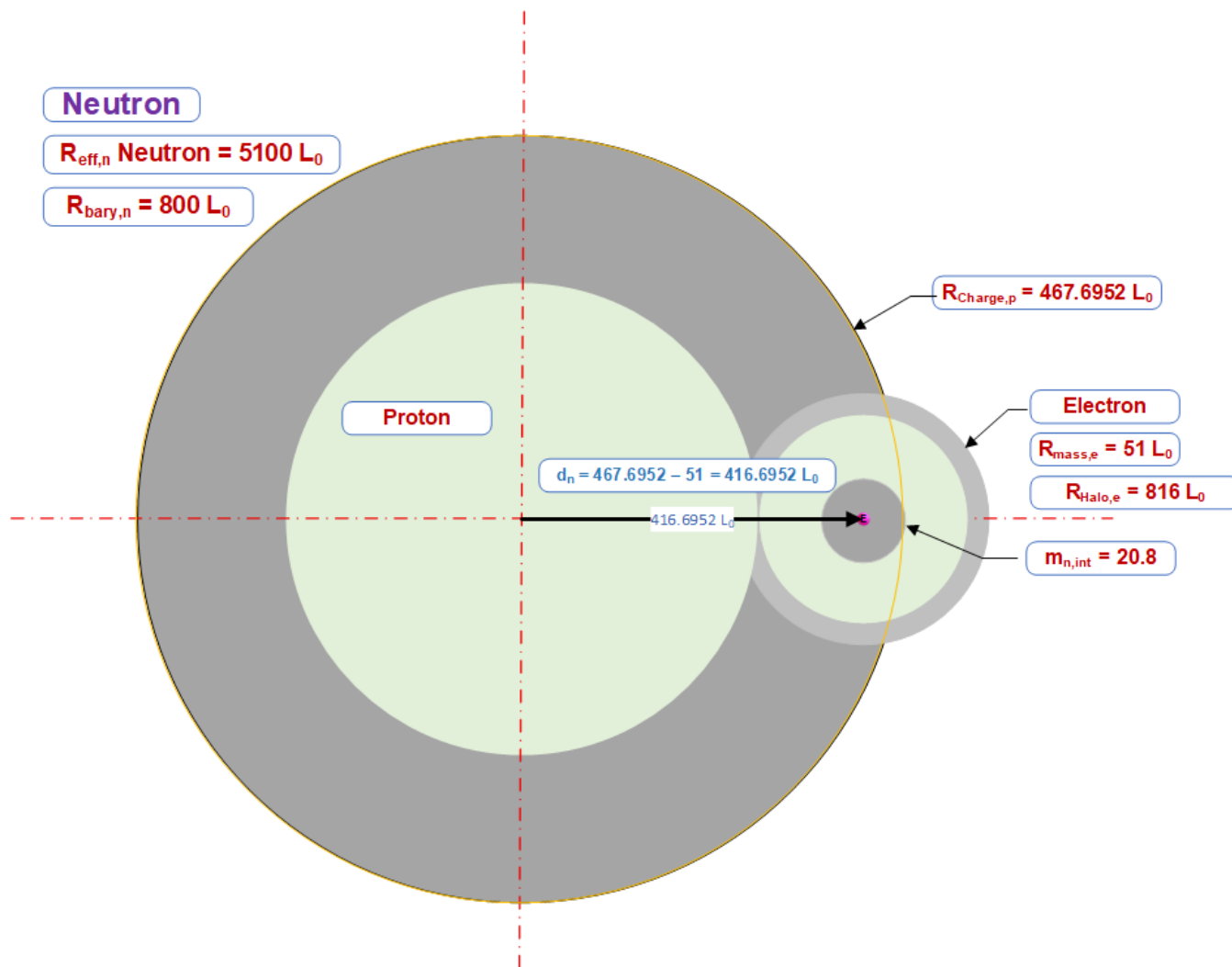
Current revision: September 2026

This document depends on
Equation of the Universe — Core Theory (Rev 3.47.0 or later)

§0 – Introduction

0.1 Definition

A neutron remains stable inside a nucleus when local p–n corridor support, Emeon/electron exchange access, and curvature closure are jointly sufficient to preserve the neutron's proton-coupled Emeon-family closure state. Within the neutron, the Emeon-family component occupies a non-terminal EZZ closure state. Beta decay occurs when that coupled closure can no longer remain phase- and geometry-clean and an accessible daughter state provides lower open curvature. The released Emeon-family component then resolves to terminal EZZZ electron closure.



0.2 Neutron Formation During the Fabric-Fusion Plateau

The proton and Emeon do not follow equivalent formation histories.

Once the proton reaches its closed $UUDZZZ$ configuration, it occupies a strongly re-closing Region state. Disturbance of the proton normally returns the structure to $UUDZZZ$; permanent loss of proton closure requires the much higher Z-class disruption regime. The proton therefore becomes effectively fixed early in the formation sequence.

The ERS symbols E , EZ , EZZ , and $EZZZ$ designate closure states and do not represent literal Zeteon inventory counts. After the Combination stage, a resolved Emeon-family Region contains one Emeon coupled to a three-Zeteon closure structure. Progression through the ERS sequence represents changes in geometric and phase closure of that same underlying four-CPP inventory.

The Emeon follows a different path. Its stable electron configuration, $EZZZ$, is the terminal member of a sequence of progressively closed Emeon-family states:

$$E \rightarrow EZ \rightarrow EZZ \rightarrow EZZZ.$$

These configurations correspond to different degrees of Zeteon closure around the same Emeon core. The non-terminal states retain unresolved curvature or phase structure and therefore remain transient, while the fully closed $EZZZ$ configuration is the stable electron Region.

During formation, the changing lattice environment permits these different closure states to exist before the final electron configuration becomes dominant. The proton may therefore already exist as a closed Region while Emeon-family structures remain distributed among incomplete closure states.

Of particular importance is the $\backslash(EZZ\backslash)$ configuration. Within the Emeon Resolved-State sequence, $\backslash(EZZ\backslash)$ corresponds to the muon state. The measured muon rest energy is approximately

$$105.658 \text{ MeV},$$

while the EOTU resolved-state construction places the corresponding $\backslash(EZZ\backslash)$ state at approximately the same energy scale.

A direct laboratory analogue establishes that this intermediate Emeon-family state can participate in neutron formation. When a negative muon enters protium, it can replace the ordinary electron and form muonic hydrogen. The resulting proton–muon system can undergo

$$p + \mu^- \rightarrow n + \nu_\mu.$$

No multi-nucleon nucleus or pre-existing neutron is required. The initial nuclear structure is a single proton, and the neutron is produced during the capture event.

In EOTU terms, this identifies an admissible formation route in which an already-closed proton Region couples to an EZZ Emeon-family Region:

$$UUDZZZ + EZZ \rightarrow \text{coupled proton-}EZZ \text{ state} \rightarrow n + \nu.$$

The intermediate coupled state is the EOTU counterpart of muonic protium.

The proton–muon transition also provides a measured energy-accounting comparison with direct proton–electron capture.

$$p + e^{-} \rightarrow n + \nu_e$$

is deficient by approximately 0.782MeV in rest-energy inventory. The muon-scale *EZZ* state contains far more than this required difference. The measured proton–muon reaction also provides an energy-accounting check on the transition. Using measured rest energies, the initial proton–muon system exceeds the neutron rest energy by approximately

$$m_p + m_{\mu} - m_n \approx 104.365 \text{ MeV.}$$

This value does not act as a formation threshold within EOTU. The structural transition is permitted by closure geometry. The measured energy difference is the ledger consequence of that transition. In laboratory muon capture, most of the available transition energy is carried by the emitted neutrino, with the remainder appearing primarily as neutron recoil.

Within EOTU, the same distinction applies: closure geometry determines whether the transition occurs; curvature and phase transport record the resulting balance. Neutron formation therefore occurs during the interval in which proton closure has already become persistent while Emeon-family Regions may still occupy non-terminal closure states.

An *EZZ* state that continues toward independent terminal closure resolves as *EZZZ*, the stable electron. An *EZZ* state that instead enters the appropriate proton-coupled closure can participate in neutron formation.

$$EZZ \rightarrow EZZZ \quad \text{terminal electron closure}$$

or

$$p + EZZ \rightarrow n + \nu \quad \text{proton-coupled neutron closure.}$$

Because *EZZ* and *EZZZ* designate closure states of the same underlying Emeon-plus-three-Zeteon inventory, this transition requires no creation, destruction, addition, or loss of a Zeteon.

Thus electrons and neutrons arise from the same post-Combination Emeon-family population after proton structure has largely stabilized. The electron represents terminal independent Emeon closure, while the neutron represents a proton-coupled non-terminal Emeon closure..

The completed neutron remains the composite Region defined in §1.1.

persistent proton closure → evolving Emeon closure → $EZZ \begin{cases} +Z \rightarrow EZZZ & \text{electron} \\ +p \rightarrow n + \nu & \text{neutron} \end{cases}$

0.3 Nuclear Beta-Decay Discriminator and Spreadsheet

The neutron structure is defined in §1. The beta-decay execution rule is defined in §2. This section establishes the role of the isotope discriminator spreadsheet as the numerical companion to that rule.

In the EOTU framework, beta decay is governed by open curvature pressure, not raw nuclear pressure. Stable nuclei may carry large internal pressure when that pressure is closed by local corridor geometry.

Beta-unstable nuclei are those in which neutron-side or proton-side pressure remains open and an isobaric daughter provides a lower-open-curvature state.

The governing discriminator is:

$$K_{\text{open}} = K_{\text{stress}} - K_{\text{closure}} - K_{\text{exchange}}$$

where K_{stress} represents unsupported local curvature burden, K_{closure} represents closure supplied by productive nuclear corridor geometry, and K_{exchange} represents Emeon/electron-exchange access that preserves the neutron's proton-coupled EZZ closure condition..

The isotope discriminator spreadsheet evaluates this rule across isotope chains by translating corridor support, contact crowding, curvature-closure access, electron-exchange access, and daughter-state relief into pressure-relief scores. The spreadsheet does not define the beta-decay rule; it tests whether the rule separates stable, β^- , EC/ β^+ , mixed, and alpha/geometric-instability cases across measured isotope chains.

§1 — Property, Phase Identity and Physical Role

The neutron is an unstable composite Region formed by coupling a closed proton Region to a non-terminal Emeon-family closure. It is not a separate primordial CPP species.

After the Combination stage, the Emeon-family component contains one Emeon coupled to a three-Zeteon closure structure. Within the neutron, this four-CPP inventory occupies the EZZ closure state. The designation EZZ identifies the degree of geometric and phase closure and does not indicate that only two Zeteons are present.

All three Zeteons remain part of the Emeon-family closure structure. The non-terminal EZZ state differs from terminal EZZZ electron closure by its unresolved geometric and phase defect, not by CPP inventory.

The neutron therefore contains ten CPPs: six in the closed proton Region and four in the coupled Emeon-family Region. The incomplete EZZ closure carries the residual internal closure burden associated with neutron metastability.

In isolation, the proton-coupled EZZ state eventually fails to re-close. Inside a nucleus, productive proton-neutron corridors, surrounding curvature geometry, and Emeon/electron exchange access can preserve that non-terminal closure.

The neutron therefore retains ten CPPs, consistent with the established neutron Region inventory, while its Emeon component remains geometrically non-terminal. The incomplete EZZ closure provides the residual curvature burden responsible for neutron metastability.

In isolation, the proton-coupled EZZ state lacks the additional geometric support required for permanent closure and eventually resolves through beta decay. Inside a nucleus, productive proton-neutron corridors and surrounding closure geometry can stabilize the incomplete EZZ configuration without converting it into a terminal electron Region.

1.1 Neutron Composition Identity

The neutron composition is:

$$n = (UUDZ_3) + (EZZ)_{\text{coupled}}$$

where:

- $UUDZ_3$ is the closed proton Region;
- EZZ_{coupled} is the four-CPP Emeon-family Region held in the non-terminal EZZ closure state;
- Δm_{int} Is the residual internal closure contribution produced by coupling that non-terminal Emeon-family state inside the proton closure envelope.

The embedded Emeon-family Region is structurally present, but it is not counted as an external additive mass-factor term. In the neutron state, the electron participates as an internal phase and charge-moment component of the composite Region. The additional mass-factor contribution is therefore the residual closure burden required to maintain the embedded non-terminal Emeon-family state.

The neutron mass-factor relation is written as:

$$m_n \equiv m_p + m_{n,int}$$

Using the working neutron inventory:

$$m_n = 30630.7801 + 0 + 20.8 = 30651.5801$$

$$E_n \approx 939.51936 \text{ MeV}$$

$$\frac{939.51936 - 939.5654133}{939.5654133} \times 100\% = -0.0049\%$$

The electron Region remains part of the neutron composition, but its external mass-factor contribution is not added separately. The neutron excess over the proton is carried by the internal closure contribution $m_{n,int}$.

1.2 Neutron Separation and Encapsulation Geometry

The neutron encapsulation geometry is modeled by coupling the compact Emeon-family closure structure inside the proton closure boundary.

Use the following radii:

$$r_{p,curv} = 459L_0$$

$$r_{p,cl} = 467.6952L_0$$

$$r_{e,cl} = 51L_0$$

where $r_{p,curv}$ is the proton curvature-only mass-closure radius, $r_{p,cl}$ is the proton closure / charge-moment boundary, and $r_{e,cl}$ is the compact Emeon-family closure scale used by the encapsulation construction.

The encapsulation condition is:

$$d_n + r_{e,cl} = r_{p,cl}$$

Substituting:

$$d_n + 51 = 467.6952$$

Therefore:

$$d_n = 467.6952 - 51 = 416.6952L_0$$

This is the electron-proton center separation for the encapsulated neutron state. The baryonic-touch approximation remains:

$$d_{bary} = 416L_0$$

The difference between the closure-boundary separation and the baryonic-touch approximation is:

$$\Delta d = 416.6952 - 416 = 0.6952 L_0$$

The encapsulated geometry therefore places the compact Emeon-family closure boundary at the proton closure / charge-moment boundary, while the baryonic-touch value remains the nearest integer contact approximation.

1.3 Proton Curvature–Closure Gap and Internal Neutron Contribution

The internal neutron contribution is governed by the radial gap between the proton curvature-only closure radius and the proton closure / charge-moment boundary.

Define:

$$\Delta r_p \equiv r_{p,cl} - r_{p,curv}$$

Using:

$$r_{p,cl} = 467.6952 L_0$$

$$r_{p,curv} = 459 L_0$$

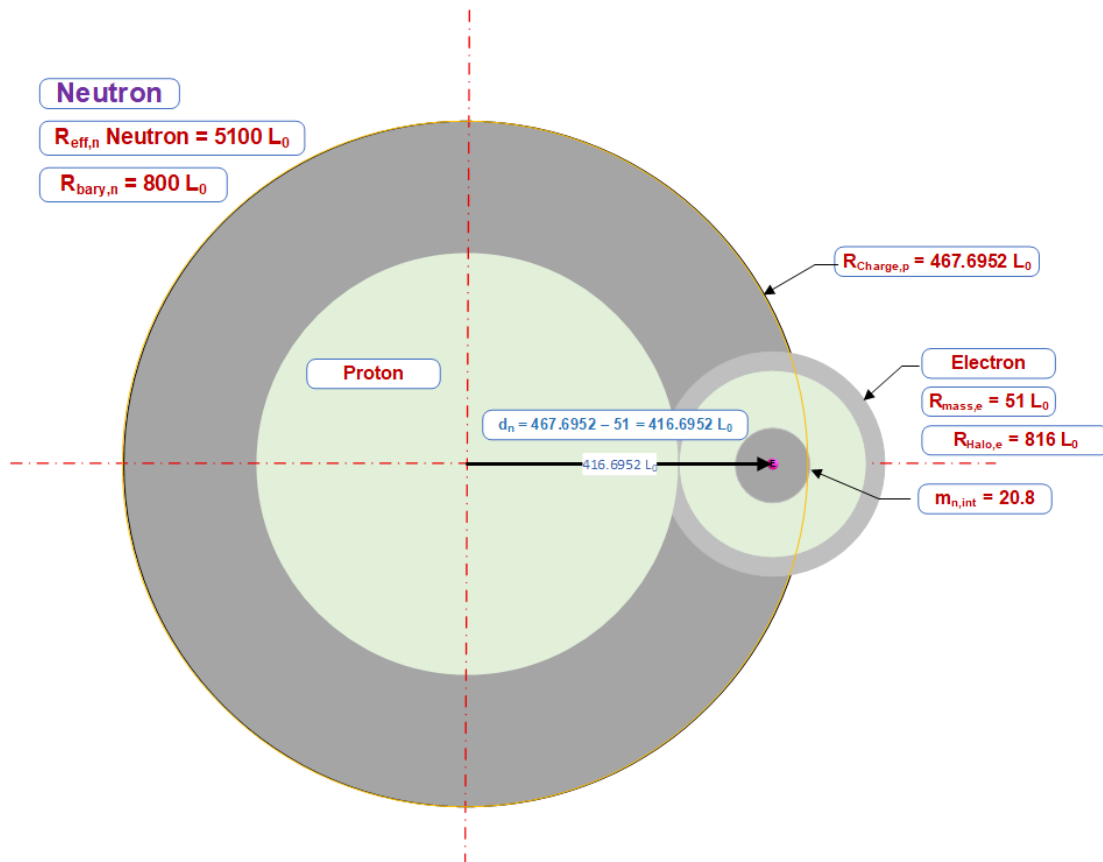
gives:

$$\Delta r_p = 467.6952 - 459 = 8.6952 L_0$$

The same residual appears when the embedded neutron separation is compared to the proton curvature-only closure radius:

$$d_n + r_{e,cl} - r_{p,curv} = 416.6952 + 51 - 459 = 8.6952 L_0$$

Thus the neutron's internal closure contribution is governed by the ratio of the proton curvature–closure shell gap to the embedded Emeon-family closure scale.



The residual closure contribution is:

$$m_{n,\text{int}} \equiv m_e \left(\frac{\Delta r_p}{r_{e,\text{cl}}} \right)^2 \equiv m_e \left(\frac{8.6952}{51} \right)^2$$

Using the electron mass factor:

$$m_e \approx 714.6767$$

gives:

$$m_{n,\text{int}} \approx 714.6767(0.17049)^2 \approx 20.8$$

This factor is the squared leakage ratio of the proton curvature–closure shell gap against the embedded Emeon-family closure scale. It represents the residual closure burden required to maintain the embedded non-terminal Emeon-family state inside the neutron geometry.

The measured neutron–proton mass-factor difference gives the comparison value:

$$m_{n,\text{int}}^{\text{meas}} \equiv m_n^{\text{meas}} - m_p = 20.7021$$

The geometric value:

$$m_{n,\text{int}} \approx 20.8$$

is therefore the working first-principles neutron internal contribution.

The retained normalization originates in the earlier encapsulation construction and does not imply that the neutron contains a terminal EZZZ electron. Under the revised ERS ontology, the internal state is the Emeon-plus-three-Zeteon inventory held in proton-coupled EZZ closure

1.4 Neutron Effective Region Reach

The neutron effective Region reach is set by the combined neutron CPP inventory:

$$N_{UUDZZZ+EZZZ} = 10$$

The neutron scale index is:

$$k_n = 10^2 = 100$$

The effective Region radius is:

$$R_{\text{eff}}(k) = 51k_n L_0$$

Therefore:

$$R_{\text{eff},n} = 51(100) L_0 = 5100 L_0$$

The baryonic core reach follows the fixed EOTU core-to-halo ratio:

$$R_{\text{bary},n} = \frac{8}{51} R_{\text{eff},n} = \frac{8}{51} (5100 L_0) = 800 L_0$$

Thus the neutron has:

$$R_{\text{eff},n} = 5100 L_0, \quad R_{\text{bary},n} = 800 L_0$$

The neutron is therefore a wider composite Region than either the proton or a free terminal electron Region. Its stability depends on whether the proton-coupled EZZ closure of the internal Emeon-family component can remain coherent inside that expanded neutron reach. In isolation, this non-terminal closure is metastable. Inside a nucleus, surrounding p-n corridor support and Emeon/electron-exchange access can preserve the coupled neutron state.

1.5 Neutron Charge-Moment Radius

The neutron is electrically neutral as a whole, but its internal charge geometry is not charge-uniform. In the EOTU framework, this follows from the neutron being a composite of a closed proton Region and a proton-coupled Emeon-family Region in a non-terminal EZZ closure state.

The positive charge contribution is carried by the proton-side active structure, while the negative charge contribution is carried by the Emeon-family component. Because that negative contribution is spatially displaced from the proton center, the positive and negative charge moments need not cancel spatially even though the total resolved charge cancels algebraically.

The neutron charge observable is therefore the signed second-moment residue of the internal proton-Emeon-family charge geometry:

$$d_n + r_{e,\text{core}} = r_{p,\text{charge}}$$

Using:

$$r_{p,\text{charge}} = 467.6952 L_0, \quad r_{e,\text{core}} = 51 L_0$$

gives:

$$d_n = 467.6952 - 51 = 416.6952 L_0$$

The neutron charge-moment relation is:

$$\langle r_n^2 \rangle_{\text{EOTU}} = r_{p,\text{charge}}^2 - (d_n^2 + r_{e,\text{participation}}^2)$$

The embedded Emeon-family component does not contribute only through its compact $51 L_0$ core. Inside the neutron, its negative charge moment participates through the proton baryonic participation basin:

$$r_{e,\text{participation}} \approx R_{\text{bary},p} = 288 L_0$$

Therefore:

$$\langle r_n^2 \rangle_{\text{EOTU}} = (467.6952)^2 - ((416.6952)^2 + (288)^2)$$

$$\langle r_n^2 \rangle_{\text{EOTU}} = -37,840.0896 L_0^2$$

Using:

$$1L_0 = 0.001797965855 \text{ fm}, \quad \langle r_n^2 \rangle_{\text{EOTU}} = -0.122325 \text{ fm}^2$$

The observed neutron mean-square charge radius is:

$$\langle r_n^2 \rangle_{\text{obs}} = -0.1161(22) \text{ fm}^2$$

$$\langle r_n^2 \rangle_{\text{obs}} = -35,914.46 L_0^2$$

$$r_{e,\text{participation,obs}} = 284.6373 L_0$$

Solving the observed value backward gives the electron participation radius required by measurement:

$$r_{e,\text{participation,obs}} = \sqrt{r_{p,\text{charge}}^2 - d_n^2 - \langle r_n^2 \rangle_{\text{obs},L_0}} = 284.6373 L_0$$

This is not an observed neutron radius; it is the electron participation radius implied by the observed charge moment.

The percent difference between the EOTU and observed mean-square charge values is:

$$\frac{|-0.122325 - (-0.1161)|}{0.1161} \times 100 = 5.36\%$$

The inferred electron participation radius is only:

$$\frac{288 - 284.6373}{288} \times 100 = 1.17\%$$

below the proton baryonic participation radius. Thus the observed neutron charge moment indicates that the embedded Emeon-family closure's negative charge moment spreads through nearly the full proton baryonic participation basin.

The negative sign is not a negative physical size. It means the displaced negative second-moment term exceeds the centered positive second-moment term:

$$d_n^2 + r_{e,\text{participation}}^2 > r_{p,\text{charge}}^2$$

The neutron charge radius is therefore a direct structural signature of the embedded Emeon-family closure geometry. It is the measurable residue of a neutral composite Region whose positive and negative charge components cancel in total charge but not in spatial moment.

1.6 Neutron Energy

The corresponding projected neutron energy is:

$$E_n = \Gamma m_n^2, \quad E_n = \Gamma(30671.1113)^2, \quad E_n = 940.7170684 \text{ MeV}$$

The measured neutron rest energy is:

$$E_n^{\text{meas}} = 939.5654133 \text{ MeV}$$

with measured mass-factor equivalent:

$$m_n^{\text{meas}} = 30652.3312$$

The energy difference is:

$$\Delta E = E_n^{\text{meas}} - E_n = 939.5654133 - 940.7170684 = -1.1516551 \text{ MeV}$$

The percent difference is:

$$\% \Delta = \frac{\Delta E}{E_n^{\text{meas}}} \cdot 100 = \frac{-1.1516551}{939.5654133} \cdot 100 \approx -0.1226\%$$

The derived neutron energy is therefore within approximately 0.1226% of the measured neutron rest energy.

§2 — β -Decay in the EOTU Framework

β -decay is the release path that occurs when a neutron-containing or proton-crowded nuclear Region contains open curvature pressure and an isobaric daughter state provides lower open curvature.

Free-neutron beta decay is an observed property of isolated neutrons and is treated separately from formation-era neutron closure. During the Fabric-Fusion Plateau, neutron formation and nuclear closure occur within the high-exchange formation environment described in the Formation framework.

A nucleus does not beta-decay merely because it has high internal pressure. Stable nuclei may carry large internal pressure when that pressure is closed by local corridor geometry. The beta-decay discriminator is therefore not total pressure. It is **open pressure**: the portion of local curvature burden that is not closed by productive corridor support, curvature-closure access, and electron-exchange access.

The governing quantity is:

$$K_{\text{open}} = K_{\text{stress}} - K_{\text{closure}} - K_{\text{exchange}}$$

where:

$$K_{\text{stress}}$$

is the local curvature burden produced by unsupported neutron-side or proton-side crowding.

$$K_{\text{closure}}$$

is the portion of that burden closed by local p–n corridor support and nuclear geometry.

$$K_{\text{exchange}}$$

is the portion relieved by Emeon/electron-exchange access that preserves the neutron’s proton-coupled EZZ closure condition.

Beta decay occurs only when the parent has positive open pressure and the daughter state lowers that open pressure.

2.1 Free-Neutron Limit

The free neutron is the isolated limit of the neutron composite Region. It contains the closed proton Region coupled to an Emeon-family Region occupying the non-terminal EZZ closure state, but it has no surrounding nuclear corridor network.

In EOTU terms, this is not the destruction of a primordial neutron particle. It is the failure of the proton-coupled EZZ closure. During release, the Emeon-family component resolves toward terminal EZZZ closure and emerges as the observed electron, while the antineutrino carries the unresolved phase component required by the transition.

The free-neutron decay condition is:

$$K_{\text{open},n} > 0$$

with no competing nuclear daughter geometry available inside the parent structure. The free-neutron path is therefore the isolated closure-failure limit:

$$n \rightarrow p + e + \nu$$

In EOTU terms, this is not the destruction of a primordial neutron particle. It is the separation of a composite proton–electron Region after the embedded EZZZ shell can no longer remain phase-clean inside the neutron geometry. The neutrino carries the unresolved phase component released during the re-separation. The neutral free-neutron lifetime baseline is the Region-neutral limit:

$$\tau_{\text{neutral}} \approx 877.8 \text{ s}$$

This value represents the isolated neutron lifetime when the measurement Region provides minimal external curvature conditioning.

2.2 Bound-Neutron β – Decay

Inside a nucleus, a neutron may remain stable if the local nuclear geometry preserves the embedded Emeon-family closure condition. The stabilizing contributions are:

- productive p–n corridor support
- curvature-closure access through the surrounding nuclear Region
- Emeon/electron-exchange access that preserves the neutron’s proton-coupled EZZ closure

Bound-neutron β^- decay occurs when neutron-side open pressure remains after these stabilizing contributions are applied, and when the isobaric daughter with $Z + 1$ and $N - 1$ lowers the open curvature burden. The β^- relief score is:

$$\Delta K_{\beta^-} = K_{\text{open}}(Z, N) - K_{\text{open}}(Z + 1, N - 1)$$

A positive value means the daughter state has lower open curvature than the parent:

$$\Delta K_{\beta^-} > 0$$

When this condition dominates the available decay paths, the nucleus follows β^- decay.

The EOTU interpretation is:

$$n_{\text{bound}} \rightarrow p_{\text{bound}} + e + \nu$$

The neutron-side open pressure is relieved by converting one neutron participation site into a proton participation site inside the same mass chain. The emitted electron is the terminal EZZZ closure reached by the released Emeon-family component, and the neutrino carries the unresolved phase transport required by the closure transition.

2.3 Proton-Side EC/ β^+ Decay

Proton-rich nuclei can carry proton-side open pressure. In these cases, the lower-open-curvature daughter may be the isobaric state with $Z - 1$ and $N + 1$.

The EC/ β^+ relief score is:

$$\Delta K_{\text{EC}} = K_{\text{open}}(Z, N) - K_{\text{open}}(Z - 1, N + 1)$$

A positive value means the daughter state has lower open curvature than the parent:

$$\Delta K_{\text{EC}} > 0$$

When this condition dominates the available decay paths, the nucleus follows electron capture or β^+ decay.

In EOTU terms, electron capture is the direct construction path:

$$p_{\text{bound}} + e \rightarrow n_{\text{bound}} + \nu$$

The proton Region accepts Emeon-family participation and forms a neutron composite when the daughter geometry permits proton-coupled non-terminal closure.

β^+ decay is the externally observed counterpart of the same proton-side relief family. It reflects the parent nucleus moving toward a lower-open-curvature daughter by reducing proton-side crowding and increasing neutron participation.

2.4 Mixed β Decay

Mixed decay occurs when both daughter directions provide positive open-curvature relief:

$$\Delta K_{\beta^-} > 0$$

and

$$\Delta K_{EC} > 0$$

In that case, the parent nucleus has both neutron-side and proton-side relief paths available. The observed branching depends on the relative relief scores and the accessibility of each daughter state.

The dominant path is the one with the larger relief:

$$\text{dominant path} = \arg \max(\Delta K_{\beta^-}, \Delta K_{EC})$$

Mixed decay is therefore not a contradiction. It indicates that the parent occupies a geometry where both isobaric daughter directions reduce open curvature.

2.5 Stable-with-Respect-to-Beta Condition

A nucleus is stable with respect to beta decay when neither isobaric daughter lowers the open curvature burden:

$$\Delta K_{\beta^-} \leq 0$$

and

$$\Delta K_{EC} \leq 0$$

This does not require the nucleus to have low total pressure. It requires the pressure to be closed.

Thus:

$$K_{\text{stress}} \text{ may be large}$$

while:

$$K_{\text{open}} \leq 0$$

or while no accessible daughter state provides positive relief.

A beta-stable nucleus is therefore a pressure-closed nuclear Region, not necessarily a low-pressure nuclear Region.

2.6 Alpha and Geometric Instability

Alpha decay and geometric breakup are separate from beta decay.

Beta decay is an isobaric pressure-relief process. It changes the proton–neutron balance while preserving mass number:

$$A = Z + N$$

Alpha decay and geometric instability are disassembly processes. They occur when the nuclear geometry favors removal or separation of a closed structural unit rather than an isobaric shift.

Therefore, the beta-discriminator must not classify all instability as beta instability. The rule is:

Beta decay requires lower open curvature through an isobaric daughter.

If the dominant relief path is not isobaric, the instability belongs to the alpha/geometric family rather than the beta family.

2.7 Unified β -Decay Execution Rule

For a nucleus with proton number Z and neutron number N , compute the parent open curvature:

$$K_{\text{open}}(Z, N)$$

Then compute the two isobaric daughter relief scores:

$$\Delta K_{\beta^-} = K_{\text{open}}(Z, N) - K_{\text{open}}(Z + 1, N - 1)$$

$$\Delta K_{EC} = K_{\text{open}}(Z, N) - K_{\text{open}}(Z - 1, N + 1)$$

A positive relief score means the daughter has lower open curvature than the parent. However, small positive relief does not necessarily produce decay. The relief must exceed the activation threshold for that decay path.

The isotope discriminator workbook uses the following activation thresholds:

$$\Theta_{\beta^-} = 0.65, \quad \Theta_{EC} = 0.25$$

Define the activated relief values:

$$R_{\beta^-} = \Delta K_{\beta^-} - \Theta_{\beta^-} = \Delta K_{\beta^-} - 0.65$$

$$R_{EC} = \Delta K_{EC} - \Theta_{EC} = \Delta K_{EC} - 0.25$$

where:

The available decay paths are determined by activated relief:

$$R_{\beta^-} > 0$$

means the β^- path is active.

$$R_{EC} > 0$$

means the EC/ β^+ path is active.

The beta-decay channel is then determined as follows:

$$\text{Stable to beta if } \Delta K_{\beta^-} \leq 0 \text{ and } \Delta K_{EC} \leq 0$$

$$\beta^- \text{ if } \Delta K_{\beta^-} > 0 \text{ and } \Delta K_{EC} \leq 0$$

$$EC/\beta^+ \text{ if } \Delta K_{EC} > 0 \text{ and } \Delta K_{\beta^-} \leq 0$$

$$\text{Mixed if } \Delta K_{\beta^-} > 0 \text{ and } \Delta K_{EC} > 0$$

For mixed cases, the dominant branch is determined by the larger activated relief:

$$\text{Dominant branch} = \arg \max(R_{\beta^-}, R_{EC})$$

This gives the resolved channel rule:

- no activated relief path $\rightarrow$ beta-stable
- only β^- activated $\rightarrow \beta^-$
- only EC/ β^+ activated $\rightarrow$ EC/ β^+
- both activated $\rightarrow$ mixed, with the dominant branch set by the larger activated relief

The activation thresholds prevent small daughter improvements from being misclassified as decay. A nucleus may have a positive daughter relief score and remain beta-stable when that relief does not exceed the activation threshold. In the workbook, neutron-side relief activates at 0.65, while proton-side EC/ β^+ relief activates at 0.25.

2.7.1 Example

For ^{40}K , the sheet gives:

$$\Delta K_{\beta^-} \approx 1.907, \quad \Delta K_{EC} \approx 0.342$$

Both exceed their apparent activation thresholds:

$$1.907 > 0.65, \quad 0.342 > 0.25$$

So the workbook correctly marks:

$$^{40}\text{K} \rightarrow \beta^-/EC$$

Appendix A — Experimental Reference: Negative-Muon Capture on the Proton

Negative-muon capture on hydrogen provides a direct laboratory example of neutron formation from a single proton coupled to a muon.

The underlying reaction is

$$\boxed{\mu^- + p \rightarrow n + \nu_\mu}$$

The MuCap experiment at the Paul Scherrer Institute measured this process using a negative-muon beam stopped in ultra-pure hydrogen gas. The stopped muon first forms a muonic-hydrogen atom, (μp) , after which nuclear muon capture can occur. The experiment measured the singlet-state capture rate from muonic hydrogen with approximately one-percent precision. [arXiv](#)

The important structural observation for the EOTU neutron model is that the nuclear target is a single proton. The process does not require a pre-existing neutron or a multi-nucleon nucleus:

$$p + \mu^- \rightarrow n + \nu_\mu.$$

Experimentally, the initial state is not an instantaneous collision between two completely unbound particles. The negative muon first becomes bound to the proton in the muonic-hydrogen system. The subsequent capture transition converts that proton–muon system into a neutron while emitting a muon neutrino.

Within EOTU, this observation establishes an experimentally demonstrated proton–muon neutron-formation channel. It does not by itself determine the internal EOTU geometry of the muon or neutron. The correspondence under investigation is

$$\mu^- \leftrightarrow EZZ$$

and therefore

$$UUDZZZ + (EZZ)_{\mu p} \rightarrow n + \nu_\mu.$$

The experimental reaction constrains the EOTU closure model: whatever CPP geometry is assigned to the muon must be capable of coupling with a single closed proton Region and resolving into the neutron state without requiring a pre-existing neutron or additional nucleon.

The measured capture rate is an experimental property of the laboratory muonic-hydrogen system. It is not adopted as an EOTU formation probability for the Fabric-Fusion Plateau. In EOTU, the measured reaction establishes physical admissibility of the transition; the formation frequency must follow from the applicable closure geometry and available formation inventory.

References

V. A. Andreev et al. (MuCap Collaboration), “Measurement of Muon Capture on the Proton to 1% Precision and Determination of the Pseudoscalar Coupling g_p ,” *Physical Review Letters* 110, 012504 (2013). The

experiment reports capture from the singlet state of muonic hydrogen using a 10-bar ultra-pure hydrogen target and gives $\Lambda_S = (714.9 \pm 5.4_{\text{stat}} \pm 5.1_{\text{syst}}) \text{ s}^{-1}$. arXiv

Paul Scherrer Institute, “Measurement of Muon Capture on the Proton to 1% Precision and Determination of the Pseudoscalar Coupling g_P ,” Scientific Highlights 2013.

Appendix Z-Measurement-Region Effects

Z.1 Electric-Dominant Measurement Regime

Electric-dominant beam measurements primarily condition phase structure rather than supplying curvature support comparable to magnetic-class Regions.

Therefore, the EOTU expectation is:

$$\tau_{\text{electric}} \approx \tau_{\text{neutral}}$$

Reported electric-dominant measurements are consistent with the neutral bottle baseline within uncertainty:

$$\tau_{\text{electric}} \approx 877.2 \text{ s}$$

compared with:

$$\tau_{\text{neutral}} \approx 877.8 \text{ s}$$

The central difference is:

$$\Delta\tau = 877.2 - 877.8 = -0.6 \text{ s}$$

This does not resolve a separate electric acceleration effect. The supported conclusion is:

$$\tau_{\text{magnetic}} > \tau_{\text{neutral}} \approx \tau_{\text{electric}}$$

The magnetic case shows curvature-supported lifetime extension. The electric-dominant case remains aligned with the neutral free-neutron baseline.

Z.2 Measurement-Region Effects in Free-Neutron Decay

The measured free-neutron lifetime is Region-conditioned. The neutron is a curvature-bearing composite Region, so the measurement environment can alter the effective re-closure interval before terminal ERS release. The neutral baseline is:

$$\tau_{\text{neutral}} \approx 877.8 \text{ s}$$

Magnetic-class beam measurements impose a structured curvature topology in the active measurement Region. In the EOTU interpretation, this external Region supplies curvature support that extends the neutron’s re-closure interval and increases the measured lifetime.

The magnetic curvature proxy is the field energy density:

$$u_B = \frac{B^2}{2\mu_0}$$

The effective decay hazard is written as:

$$\lambda_{\text{eff}} = \lambda_{\text{neutral}} - \kappa_B u_B$$

where:

$$\lambda_{\text{neutral}} = \frac{1}{\tau_{\text{neutral}}}$$

The observed magnetic-class uplift is approximately:

$$\Delta\tau_{\text{mag}} \approx 10.3 \text{ s}$$

with:

$$\tau_{\text{mag}} \approx 888.1 \text{ s}$$

The corresponding hazard shift is:

$$\Delta\lambda_{\text{mag}} = \frac{1}{\tau_{\text{neutral}}} - \frac{1}{\tau_{\text{mag}}} \approx 1.3 \times 10^{-5} \text{ s}^{-1}$$

For a representative magnetic-class field of:

$$B = 4.6 \text{ T}$$

the magnetic energy density is:

$$u_B(4.6 \text{ T}) = \frac{(4.6)^2}{2\mu_0} \approx 8.4 \times 10^6 \text{ J/m}^3$$

The calibrated magnetic support coefficient is:

$$\kappa_B \approx \frac{\Delta\lambda_{\text{mag}}}{u_B(4.6 \text{ T})} \approx 1.5 \times 10^{-12} \frac{\text{m}^3}{\text{J} \cdot \text{s}}$$

Since:

$$u_B \propto B^2$$

the lifetime uplift scales as:

$$\Delta\tau(B) \approx \Delta\tau(4.6 \text{ T}) \left(\frac{B}{4.6} \right)^2$$

Using:

$$\Delta\tau(4.6 \text{ T}) \approx 10.3 \text{ s}$$

gives:

$$B = 1 \text{ T} \Rightarrow \Delta\tau \approx 0.49 \text{ s}$$

$$B = 2 \text{ T} \Rightarrow \Delta\tau \approx 1.95 \text{ s}$$

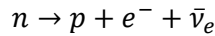
$$B = 3 \text{ T} \Rightarrow \Delta\tau \approx 4.38 \text{ s}$$

$$B = 4.6 \text{ T} \Rightarrow \Delta\tau \approx 10.3 \text{ s}$$

This measurement effect applies to free-neutron lifetime experiments. It is not the same as nuclear beta instability. Nuclear beta decay is governed by open curvature relief through daughter states. Free-neutron lifetime measurements are governed by the closure-failure interval of an isolated neutron composite under the imposed measurement Region.

Z.3 — Free-Neutron Beta-Decay Available Energy

A free neutron decays through



The total energy available to the decay products is determined by the measured rest-energy difference between the initial neutron and the final proton and electron:

$$Q_\beta = E_n - E_p - E_e$$

Using the measured rest energies,

$$E_n \approx 939.56542 \text{ MeV}$$

$$E_p \approx 938.27209 \text{ MeV}$$

$$E_e \approx 0.510999 \text{ MeV}$$

gives

$$Q_\beta \approx 0.78233 \text{ MeV}$$

Therefore, the free-neutron beta-decay available energy is

$Q_\beta \approx 0.7823 \text{ MeV}$

This energy is not the neutron rest energy. It is the excess rest-energy inventory available after formation of the daughter proton and electron. The available energy is distributed among the emitted electron, antineutrino, and the small recoil energy of the proton.

Within the EOTU neutron-decay description, this measured value provides the empirical energy constraint that the resolved neutron-to-proton transition must reproduce.