Equation of the Universe:

Neutrinos

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Author: Glenn R. King
Independent Researcher, Akron, Ohio, USA
Email: Gking@DMsHelper.com

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§0 — Introduction

0.1 Definition

Within the EOTU framework, the neutrino is the first-principles transport object for unresolved phase Δϕ within the lattice. It arises when unresolved phase must be carried out of a compound Region in order for local closure to be preserved. The most common case is Emeon decay, in which the Zeteon triad shell transitions through a phase-resolution exchange or re-lock event. The neutrino is therefore not an auxiliary byproduct, but the discrete transport of unresolved phase Δϕ itself. When a system cannot complete phase closure internally, the excess phase is released through an allowed transport channel as a neutrino. The neutrino is the fundamental phase-transfer quantum of the framework.

0.2 Emission, Propagation, and Absorption

The emitted identity of a neutrino is determined by the phase-resolution event that produced it, while the measured neutrino energy is the observational projection of that underlying phase release, with the released binding energy appearing fully as neutrino energy in two-body limits or being statistically partitioned in higher-body transitions.

Neutrino emissions are most common in the Emeon decay ladder. Two-body channels produce discrete fixed neutrino energies, while higher-body channels produce continuous spectra with fixed endpoints. In the decay ladder, charged pion, charged kaon, and tau channels provide fixed neutrino lines, while beta decay and muon decay provide distributed neutrino spectra. Thus the EOTU neutrino framework already separates discrete phase-release events from distributed phase-release events without requiring different transport rules.

Due to their small curvatures, neutrino interaction is extremely low. As a result, they can pass through enormous amounts of material with almost no observable effect. Within the EOTU framework, this means neutrino absorption is admitted but rare. The dominant resolved neutrino behavior is therefore emission and propagation, while absorption is treated as a constrained receiving event rather than the primary neutrino process.

The neutrino framework is therefore governed by four simple principles:

- a neutrino is created only by a phase-resolution event generally involving incomplete Zeteon Triad
- it transports unresolved phase Δϕ
- it propagates without changing emitted identity through the post–Freeze-Out transport structure
- absorption is possible, but rare, and occurs only through an admissible receiving condition

The neutrino is a transported phase packet whose resolved behavior is governed primarily by emission and propagation, with absorption retained as a rare but admissible receiving case within the EOTU Framework.

§1 — Properties

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

- L_0= fundamental lattice length unit
- λ_k= fixed King wavelength
- τ_0= intrinsic update interval
- $\Delta\phi$= unresolved phase transport
- n_ν= neutrino count associated with admissible phase release
- E_ν= observed neutrino energy as the projection of the underlying phase-release event

A compound Region is a coherent multi-cell structure whose internal phase state may require re-lock or exchange during an admissible transition. The neutrino is the fundamental phase-transfer quantum of the framework, and neutrino-emitting processes arise through zeteon exchange or re-lock events. In two-body limits, the released binding energy appears fully as neutrino energy. In higher-body transitions, that same release is statistically partitioned among multiple products.

1.1 Anchor Set

The energy–phase relation

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

Using $E_\nu = \Gamma(\Delta\phi)^2$, the decay ladder maps directly to the energy ladder.

Measured ionization energy:

- neutron beta-decay endpoint: 0.782MeV
- muon decay endpoint: 52.8MeV
- charged pion line: 29.79214MeV
- charged kaon line: 235.53182MeV
- tau to pion line: 882.98367MeV
- tau to kaon line: 819.88690MeV

Stable electron 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 Decay energy ladder.

These values define the neutrino scale. Two-body channels supply fixed discrete neutrino energies, while higher-body channels supply continuous spectra with fixed endpoints.

1.2 State Identification

A neutrino-emitting state is identified by the admissible phase-resolution event that produces the emitted phase release. The relevant state labels are

$$S_\nu = (\text{source family,body class,release class})$$

where

- source family identifies the emitting decay family
- body class distinguishes two-body from higher-body transitions
- release class distinguishes fixed discrete release from distributed endpoint release

Thus the neutrino ladder separates naturally into two classes:

- **fixed discrete release** — charged pion, charged kaon, and tau channels
- **distributed release** — neutron beta decay and muon decay

The measured neutrino energy is not the full identity of the state. It is the observed value associated with the admissible phase-release event that produced the neutrino.

1.3 Step-Locked Motion: One Hop per King Cycle

Neutrino propagation is synchronized to the King cycle. Each hop across one transport cell occurs exactly once per $\tau_0$interval. Because the transport spacing is fixed by λ_k, the fundamental propagation law is

$$c = \frac{\lambda_k}{\tau_0}$$

Thus neutrino motion is step-locked to the intrinsic lattice timing. The propagation rate is determined by lattice geometry and update timing rather than by a free dynamical speed variable. During propagation, the emitted phase packet preserves its transported identity unless and until an admissible receiving event occurs.

1.4 Neutrino Release Mapping

Neutrino energies map to an implied phase position through the relation

$$x = \sqrt{\frac{E_\nu}{E_{\max}}}$$

and

$$\theta = \frac{\pi}{2} + \frac{\pi}{2} x$$

Two anchors define the phase scale:

- **tau anchor**, with $E_{\max} = 882.98367\text{MeV}$
- **Z anchor**, with $E_{\max} = 91.187\text{GeV}$

Under the tau anchor, the neutrino channels stratify from low-disruption cases near the lower phase bound through kaon-scale mid disruption to tau-scale maximum disruption. Under the Z anchor, the same channels occupy a narrow band above $\pi/2$, while the W and Z states extend the scale upward. The mapping connects measured neutrino energy to implied phase position.

1.5 Interaction with Coupled Regions

A neutrino does not interact with a target merely because it reaches that target. Because neutrino interaction is extremely rare, neutrino acceptance occurs only as a constrained receiving event. A receiving Region must already expose an admissible phase-acceptance condition for the same transported phase class.

Thus the interaction rule is

$$\nu + X \to X^{*} \text{only if the target exposes an admissible receiving phase condition}$$

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

If no such receiving condition exists, no true absorption occurs. The neutrino continues in transport without being accepted by the target. In this form, neutrino interaction is governed by the receiving structure rather than by mere passage through material.

§2 — Emission Mechanics

Neutrino emission in the EOTU framework is the discrete release of unresolved phase by an admissible phase-resolution event. A neutrino is not emitted as a continuous leakage and is not produced by generic motion through the lattice. It is generated only when a composite or transient Region reaches a permitted exchange, re-lock, or decay event in which phase cannot remain locally bound and must be exported through the neutrino transport channel. The neutrino is the fundamental phase-transfer quantum, and neutrino-emitting processes arise through zeteon exchange or re-lock events.

2.1 Trigger Condition for Emission

A neutrino may be emitted only when a Region or coupled decay structure undergoes an admissible phase-resolution event and unresolved phase must be exported from the local system. In two-body limits, the released phase-associated binding energy appears as a fixed emitted neutrino energy. In higher-body transitions, that same release is distributed among multiple products and the neutrino energy becomes continuous with a fixed endpoint.

$$\text{Admissible phase-resolution event} \to \text{export of unresolved phase} \to \nu$$

This is the neutrino-emission law.

2.2 Discrete Emission Rule

Each neutrino emission event is discrete and complete. One admissible phase-resolution event produces one emitted neutrino packet. If multiple neutrinos are emitted in a higher-body event, they arise from the admissible structure of that event and not from continuous release from a single unresolved packet.

Repeated or multiple neutrino emission occurs only through distinct admissible event structure. Two-body channels produce one fixed emitted neutrino energy. Higher-body channels produce distributed spectra and may involve more than one neutrino in the final state. The neutrino is therefore tied to the specific phase-resolution grammar of the event that formed it.

2.3 Fixed and Distributed Emission

The neutrino framework separates emission into two classes.

Fixed discrete emission occurs in two-body channels. In these cases, the phase-associated release appears as a single fixed neutrino energy in the parent rest frame. Charged pion channels, charged kaon channels, and tau channels belong to this class.

Distributed emission occurs in higher-body channels. In these cases, the released phase-associated energy is partitioned among multiple products, so the emitted neutrino does not appear as a single fixed line but as part of a continuous spectrum with a fixed endpoint. Neutron beta decay and muon decay belong to this class.

Thus the same phase-release law admits both discrete and distributed neutrino emission. The difference lies in the admissible event structure, not in the existence of a different neutrino type.

2.4 Emission Ladder

The neutrino ladder exhibits a clear ordered structure. At the low-energy end are the distributed endpoint cases of neutron beta decay and muon decay. Above these appear the fixed discrete pion and kaon lines. At the high end of the ladder are the tau channels, which define the upper fixed lines of the neutrino scale.

In measured-energy form, the ladder is:

- neutron beta endpoint: 0.782MeV
- muon endpoint: 52.8MeV
- charged pion line: 29.79214MeV
- charged kaon line: 235.53182MeV
- tau to kaon line: 819.88690MeV
- tau to pion line: 882.98367MeV

These values define the neutrino emission ladder.

2.5 Phase-Position Projection at Emission

The emitted neutrino energy maps onto an implied phase position through the relation

$$x = \sqrt{\frac{E_\nu}{E_{\max}}}$$

and

$$\theta = \frac{\pi}{2} + \frac{\pi}{2}x$$

Under the tau-anchored form, the low-energy distributed cases lie close to the lower phase bound, while kaon and tau channels occupy progressively higher implied phase positions. Under the Z-anchored form, the same channels occupy a compressed band above $\pi/2$.

The mapping projects emitted energy onto implied phase position. The emission law remains the export of unresolved phase through an admissible event.

2.6 Summary of Emission Mechanics

- Neutrino emission is governed by a simple set of rules:
- emission occurs only through an admissible phase-resolution event
- the event exports unresolved phase from the local Region
- each neutrino emission is discrete and event-specific
- two-body channels produce fixed discrete neutrino energies
- higher-body channels produce distributed spectra with fixed endpoints
- the neutrino ladder is ordered by measured emitted energy and maps onto implied phase position

In this form, the neutrino is a phase-release packet formed directly from admissible phase-resolution events within the EOTU framework.

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§3 — Propagation Mechanics

Neutrino propagation in the EOTU framework is governed by the fixed geometry of the transport lattice and the universal timing of the King cycle. After emission, the neutrino travels as a discrete phase packet whose transported identity is preserved throughout free motion. Propagation does not redefine the neutrino, does not broaden its phase class, and does not convert it into a different transport object. The emitted phase packet remains the same packet until an admissible receiving event occurs.

3.1 Transport-Constrained Motion

After emission, a neutrino is bound to the post–Freeze-Out transport structure. The neutrino propagates as a discrete phase packet whose operative identity is set by the phase-resolution event that formed it. Only the fixed transport pathways of the lattice permit neutrino motion after emission.

3.2 Single-Hop Update Rule

Neutrino propagation is discretized. Each hop from one transport 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 neutrino transport rule. Packet identity is preserved during propagation.

3.3 No Acceleration, No Deceleration, No Self-Conversion

During free propagation, the neutrino does not self-evolve into a different phase packet. Its emitted identity remains fixed unless and until interaction occurs with an admissible receiving condition. Thus any selective behavior belongs to emission and absorption, not to in-flight transformation.

3.4 Weak Interaction During Transit

Neutrino interaction during transit is extremely rare. As a result, a neutrino can pass through enormous amounts of material with little or no observable effect. This rarity does not alter the propagation law. It means only that most targets do not expose the required receiving condition for acceptance. The neutrino therefore continues in transport unchanged through the lattice until such a condition is met.

3.5 Geometric Dilution

For an isotropic emitter, neutrino transport proceeds through the network of allowed transport routes embedded in the surrounding Region geometry. As distance from the emission site increases, the number of accessible routes intersecting a given shell grows with shell area. Consequently, the fraction of emitted neutrinos intersecting a fixed detector area decreases with distance.

This produces geometric dilution of received neutrino rate without requiring in-flight neutrino loss or change of packet identity. The neutrino remains unchanged in propagation; dilution arises solely from route geometry.

3.6 Summary of Propagation Mechanics

- Neutrino propagation is governed by a simple set of rules:
- propagation occurs only through the fixed transport structure of the lattice
- each hop spans one transport cell per τ_0
- the neutrino preserves emitted identity during free motion
- free propagation does not accelerate, decelerate, or convert the packet
- interaction during transit is rare
- dilution of detected flux arises from geometry, not from loss of packet identity

In this form, neutrino propagation is discrete, identity-preserving, and step-locked to the King cycle.

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§4 — Absorption Mechanics

Neutrino absorption is rare. It occurs only when an incoming neutrino reaches a Region that already exposes an admissible receiving phase condition for the transported phase class carried by that neutrino. When that receiving condition is present, the target completes the permitted receiving transition and the neutrino ceases to exist as an independent propagated object.

$$\nu + X \rightarrow X^*$$

If no such receiving condition exists, no absorption occurs and the neutrino continues in transport unchanged.

$$\nu + X \nrightarrow X^*$$

Thus neutrino absorption is a constrained receiving event rather than a dominant neutrino behavior.

A real-world examples is: **radiochemical solar-neutrino capture in chlorine**, as in the Davis/Homestake experiment, where solar neutrinos were detected by capture on chlorine nuclei