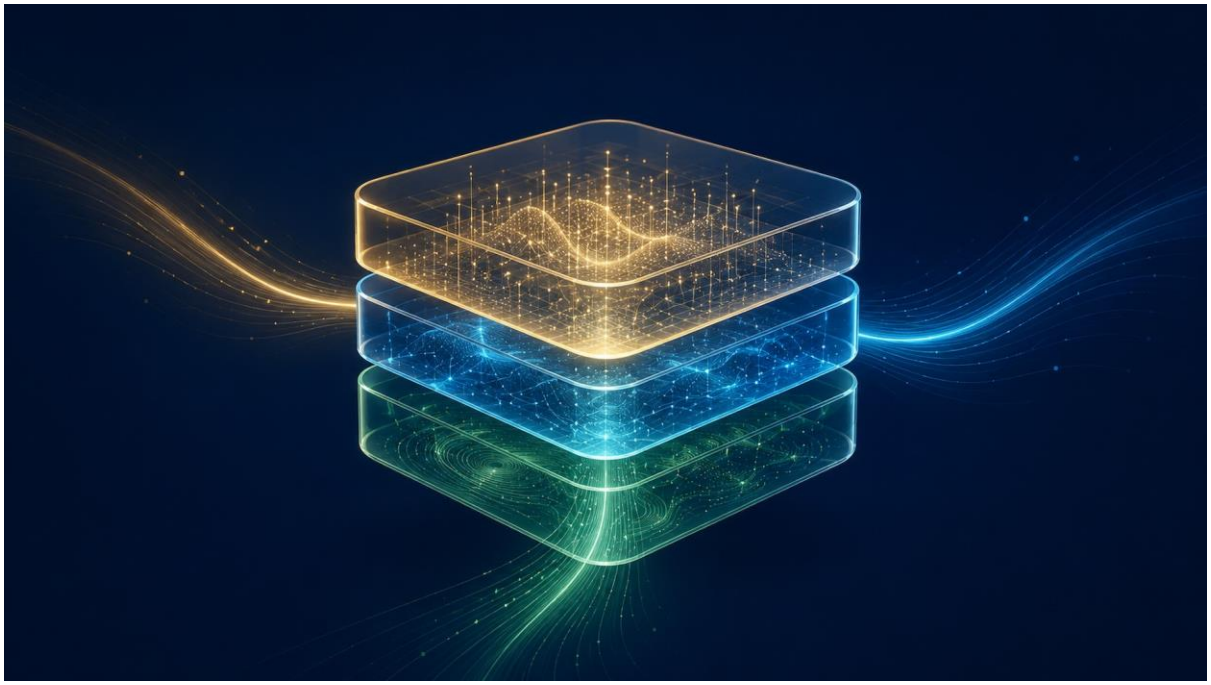
Scientific Questions, Model Assumptions and Experimental Context of the Schubart Master Formula



Clarifying Assumptions. Connecting Models. Grounding Answers in Experiment.

Clarifying the Question Before the Answer

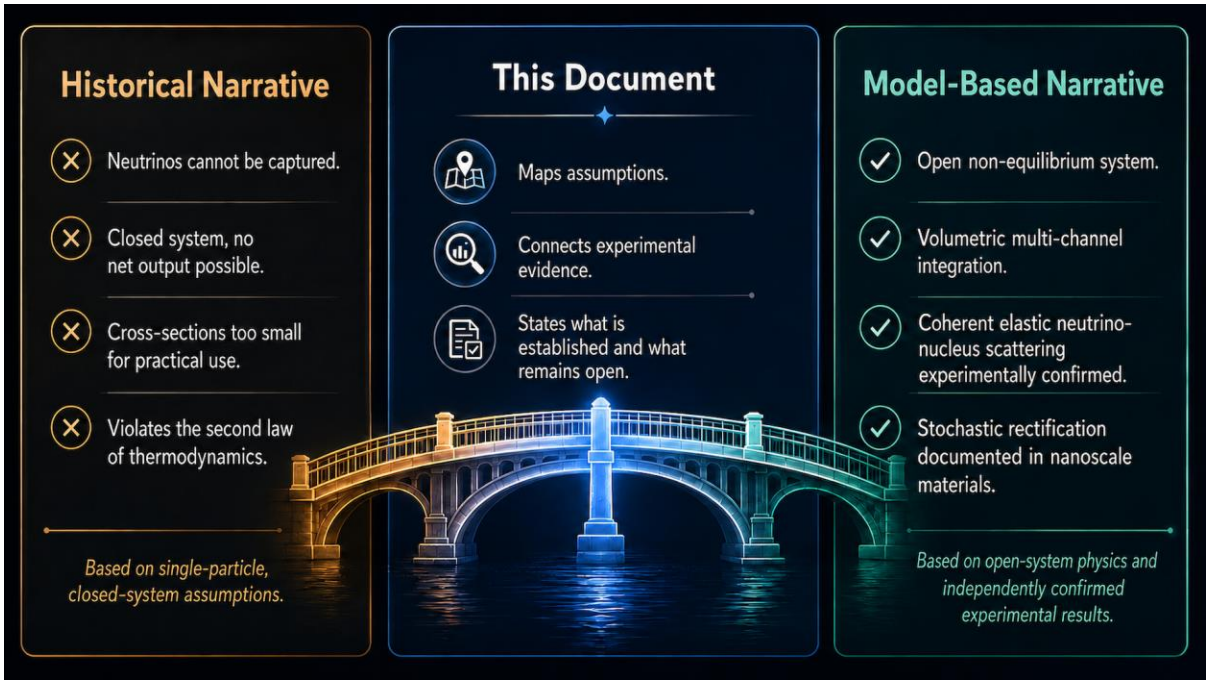
Two distinct bodies of scientific discourse surround neutrinovoltaic technology. The first emerged from classical particle physics, built around single-particle interaction models, passive single-layer material assumptions, and closed-system thermodynamics. It produced objections, including the claim that neutrinos cannot be captured, that continuous ambient flux cannot produce net work without violating the second law, and that the relevant interaction cross-sections are too small for any practical application. These objections were internally coherent within their own assumptions. They were not made in bad faith, and they should not be treated as if they were.

The second body of discourse is built around the Schubart Master Formula. It treats the system as open, non-equilibrium, multi-channel, and volumetric. It makes different physical

assumptions than the classical discourse, and several of those assumptions have since been independently confirmed by experimental results conducted at institutions with no connection to neutrinovoltaic research.

This document places those two bodies of discourse in direct, structured comparison. It does not declare one side victorious. It makes the assumptions behind each position visible, connects them to the available experimental record, and states clearly what is established and what remains open. A reader who expects triumphalism will not find it here. A reader who expects defensiveness will not find that either. What follows is a structured mapping of a scientific question that is worth taking seriously.

Science advances through better questions and clearer assumptions, not through winning arguments.

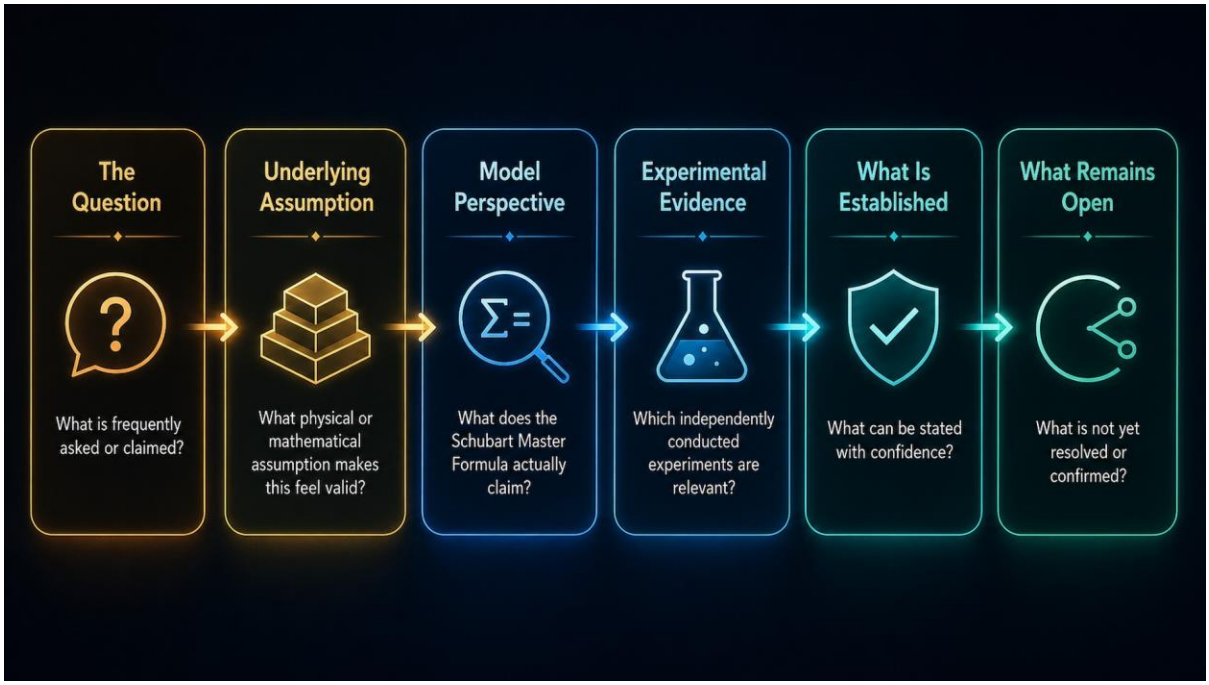


How to Read This Document

Every FAQ entry in Section Four follows the same six-column structure, presented as prose paragraphs:

- **The Question.** What is frequently asked or claimed.
- **Underlying Assumption.** What physical or mathematical assumption makes the question or objection feel valid.

- **Model Perspective.** What the Schubart Master Formula actually claims, and why it uses a different assumption.
- **Experimental Evidence.** Which independently conducted experiments are directly relevant.
- **What Is Established.** What can be stated with confidence based on model and experiment combined.
- **What Remains Open.** What is not yet resolved, not yet measured at scale, or not yet independently confirmed.



The Historical Arc — From Classical Objection to Experimental Revision

In 1934, Hans Bethe and Rudolf Peierls calculated the neutrino-nucleon interaction cross-section and arrived at a number that would define the next eight decades of physics intuition: approximately 10^{-44} cm². To put that in physical terms, a light-year-thick column of lead would stop only a fraction of passing neutrinos.

This calculation was correct within its assumptions, which were single-particle, single-nucleon, and passive-material. The conclusion that followed, namely that neutrinos could never constitute a useful energy source, was equally correct within those assumptions. For the model it used, it was a settled result. Physicists applied it not as a simplification but as a boundary condition, and for several decades, treating it as such was entirely reasonable.

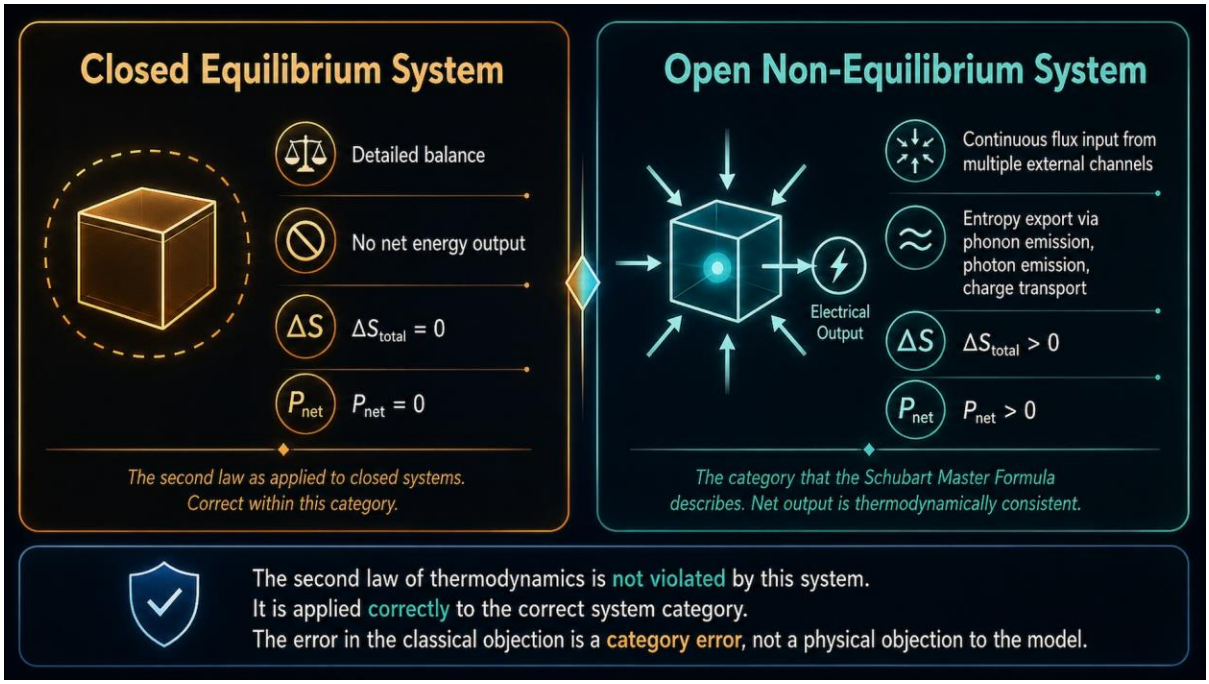
The Schubart Master Formula did not contest the Bethe-Peierls result. It changed the frame. The formula does not require stopping neutrinos or localising them within a material. The relevant physical event is coherent momentum transfer to an atomic nucleus, a process in which the neutrino continues past the nucleus but leaves a recoil behind. The volume integral $\int V$ in the formula is the mathematical response to the single-particle objection: the probability of one neutrino interacting with one nucleon is vanishingly small, but in the three-dimensional volume of an engineered nanomaterial there are trillions of atoms, and approximately 65 billion neutrinos pass through every square centimetre every second.

The volume integral aggregates those individually negligible contributions into a macroscopically relevant result, provided the material architecture is engineered to respond appropriately. The formula also does not rely on neutrinos as a single input channel. It integrates cosmic muons, electromagnetic background fields, thermal fluctuations, and mechanical vibrations simultaneously. The single-channel limitation of the classical model is resolved at the level of the framework's architecture, not by contesting any individual physical constant.

In 2017, the COHERENT collaboration at Oak Ridge National Laboratory published the first experimental confirmation of coherent elastic neutrino-nucleus scattering, CEνNS. The interaction had been predicted theoretically by Daniel Freedman in 1974 but remained unconfirmed for 43 years. In the COHERENT experiment, a 14.6-kilogram caesium iodide detector placed 19.3 metres from a neutron spallation source detected the coherent nuclear recoil with statistical significance exceeding six sigma.

The cross-section for this interaction scales with the square of the neutron number of the target nucleus, N^2, producing effective cross-sections orders of magnitude larger than Bethe-Peierls single-nucleon estimates for engineered materials with heavy nuclei. The CONUS+ experiment at a reactor neutrino source subsequently confirmed CEνNS in the coherent regime. These results were conducted by independent collaborations with no connection to neutrinovoltaic research.

They confirmed, at high statistical confidence, a key physical assumption of the Schubart Master Formula: that coherent nuclear scattering is real, measurable, and scalable with neutron number. Where a criticism rests on an assumption the experimental record has superseded, this document states that clearly. Where questions remain open, it states that with equal clarity.



The FAQ Entries

Entry 1: "Neutrinos cannot be captured."

The Question. This objection appears in its strongest form as: neutrinos interact with matter so rarely that no device could ever extract useful energy from them. Any technology claiming to do so either misunderstands neutrino physics or is making an extraordinary claim without extraordinary evidence.

Underlying Assumption. Capture means localisation or stopping of individual neutrinos. Since individual neutrino-nucleon interaction cross-sections are approximately 10^{-44} cm², the probability of any individual neutrino interacting usefully with any individual atom in a material is effectively zero. This assumption treats the relevant physical event as individual neutrino absorption in a passive, single-layer material. Given that assumption, the objection is internally sound.

Model Perspective. The Schubart Master Formula does not require capturing neutrinos. The relevant physical event is coherent elastic neutrino-nucleus scattering, CEvNS, which transfers momentum to an entire atomic nucleus without stopping the neutrino or requiring its localisation. The governing framework is: $P(t) = \eta \cdot \int V \, \Phi_eff(r,t) \cdot \sigma_eff(E) \, dV$

Here, η is the thermodynamic conversion efficiency of the material architecture; Φ_eff(r,t) integrates all contributing ambient flux channels at position r and time t, including neutrinos, cosmic muons, electromagnetic background fields, thermal gradients, and mechanical vibrations; σ_eff(E) is the effective coupling cross-section under the coherent nuclear model, which scales as N^2, where N is the neutron number of the target nucleus, producing effective cross-sections orders of magnitude larger than single-nucleon Bethe-Peierls estimates; and the volume integral ∫V aggregates contributions across the three-dimensional active material, where trillions of atoms present a cumulative interaction probability that is not negligible even at individually vanishing single-nucleon rates. Capture in the classical sense is not the mechanism. Coherent momentum transfer is.

Experimental Evidence. COHERENT collaboration at Oak Ridge National Laboratory, 2017: first experimental confirmation of CEνNS at above six sigma statistical significance, using caesium iodide and subsequent argon targets. CONUS+ reactor neutrino experiment: confirmed CEνNS in the coherent regime with reactor-source neutrinos. LZ experiment: CEνNS detection at 4.5 sigma. All three results are from independent institutions with no connection to neutrinovoltaic research.

What Is Established. Neutrinos interact with atomic nuclei through coherent elastic scattering. The recoil is real, measurable, and confirmed at high statistical significance by multiple independent collaborations. The effective cross-section for CEνNS is not 10^{-44} cm^2. It scales as N^2 and is orders of magnitude larger for engineered materials with heavy nuclei. The assumption underlying this objection, that single-nucleon Bethe-Peierls cross-sections describe the relevant interaction, is physically incorrect as applied to the coherent nuclear model.

What Remains Open. Precise engineering optimisation of material architecture to maximise effective coupling across the full ambient spectrum at industrial volumes. Layer spacing, impedance matching, and heavy-nucleus material selection remain active research parameters not yet fully characterised at deployment scale.

Entry 2: "This violates the second law of thermodynamics."

The Question. Any device claiming to extract continuous electrical work from the ambient environment without a clear external energy gradient must violate the second law of

thermodynamics. This is the most frequently cited objection in formal scientific contexts, and it carries the most institutional weight.

Underlying Assumption. The system is treated as closed and in thermodynamic equilibrium with its environment. In a closed system at thermal equilibrium, no net electrical work can be extracted from a single ambient temperature reservoir without violating entropy constraints. This is a correct statement about closed systems. The assumption that makes the objection valid is the assumption that the neutrinovoltaic system is a closed system.

Model Perspective. The Schubart Master Formula describes an open, continuously driven, non-equilibrium system. Six ambient input channels, neutrinos, cosmic muons, electromagnetic background fields, infrared radiation, thermal gradients, and mechanical vibrations, continuously supply energy from outside the system boundary. Entropy is exported via phonon emission, photon emission, charge separation, and dissipation into the surrounding environment. The total entropy of system plus environment increases. The second law is satisfied. The Nobel Prize in Chemistry 1977 was awarded to Ilya Prigogine precisely for establishing the thermodynamics of dissipative structures in open systems, which demonstrated rigorously that self-organised, directed energy conversion is possible in systems that are open and continuously driven. The application of closed-system second law reasoning to an open non-equilibrium system is a category error. It is not a physical objection to the model. It is a classification error about which category of system is being discussed.

Experimental Evidence. All six ambient input channels are independently measurable and confirmed as continuously nonzero everywhere on Earth. The entropy export mechanisms, phonon emission, charge transport, and electromagnetic radiation, are physically documented in the materials science literature across multiple independent research programmes.

What Is Established. Net power output from an open non-equilibrium system is thermodynamically consistent. The classification of the neutrinovoltaic system as open rather than closed is physically accurate and determines which thermodynamic framework applies. The classical second law objection is inapplicable as stated to this system category.

What Remains Open. Precise entropy accounting across all input channels under realistic full-deployment operating conditions at industrial volume remains an active modelling task. The aggregate thermodynamic balance has not been measured at scale in a deployed system.

Entry 3: "Thermal noise cannot be converted into work. Vibrations average to zero."

The Question. The fluctuation-dissipation theorem establishes that net work cannot be extracted from thermal fluctuations at a single temperature. Even if graphene vibrates, those vibrations are random and symmetric, so no net directional electrical current can result.

Underlying Assumption. The material is passive and symmetric. Thermal vibrations are undirected and cancel over time. The system is in thermal equilibrium with its environment and has no external driving force. These are correct assumptions for a passive symmetric material at thermal equilibrium. The objection is internally valid under those conditions.

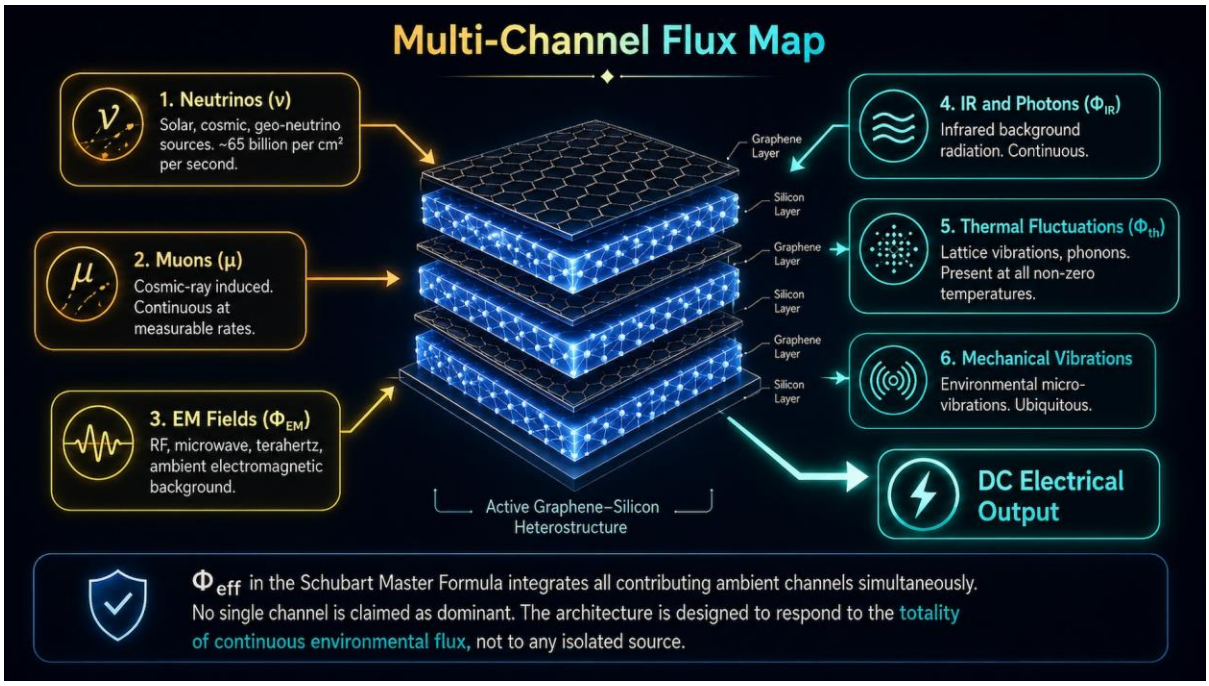
Model Perspective. The model does not treat thermal noise as a work source. The relevant excitation is not equilibrium thermal vibration. External particle and field interactions, CEνNS momentum transfer, muon ionisation, electromagnetic coupling, drive persistent non-equilibrium lattice oscillations that are not symmetrically distributed. These driven oscillations interact with the asymmetric potential landscape of an engineered graphene-silicon nanostructure, in which the spatial symmetry is deliberately broken through interface engineering and material doping profiles. In an asymmetric system, electrons have a preferred direction of drift under stochastic excitation. That drift is a net directional current. The process is stochastic rectification, documented in the non-equilibrium physics literature as a real and reproducible phenomenon. Heat is not the energy source in this model. It is the propagation medium for externally driven excitation, and it is not being extracted from equilibrium. External momentum is being rectified through an asymmetric material architecture.

Experimental Evidence. Professor Paul Thibado at the University of Arkansas demonstrated that freestanding graphene at room temperature produces continuous measurable electrical output from driven lattice vibrations in a circuit with a load, published in peer-reviewed literature. The graphene Dirac fluid, observed by a joint Indo-Japanese research team, demonstrates super-ballistic electron transport and a fundamental violation of the Wiedemann-Franz law, confirming that charge and heat transport in graphene are decoupled in precisely the way that neutrinovoltaic conversion requires. Josephson diode rectification efficiencies have been demonstrated in specific regimes at near-thermodynamic limits.

What Is Established. Stochastic rectification in asymmetric nanoscale systems is experimentally confirmed. Externally driven vibrations in asymmetric material architectures do not average to zero net current when the symmetry condition required for cancellation is

deliberately removed by engineering. The equilibrium thermal noise objection does not apply to a non-equilibrium, asymmetrically architected system under external flux excitation.

What Remains Open. Quantitative contributions of specific vibrational modes in large-scale multilayer stacks under varying ambient flux conditions require further experimental characterisation. Coupling efficiency between external flux excitation and productive vibrational modes has not been independently measured at full deployment scale.



Entry 4: "The interaction cross-sections are too small. You cannot scale to useful power levels."

The Question. Even accepting that some interaction exists, the cross-sections involved are too small for any practical volume of material to produce useful electrical output. Linear scaling from known neutrino interaction probabilities gives negligible results that no engineering improvement can overcome.

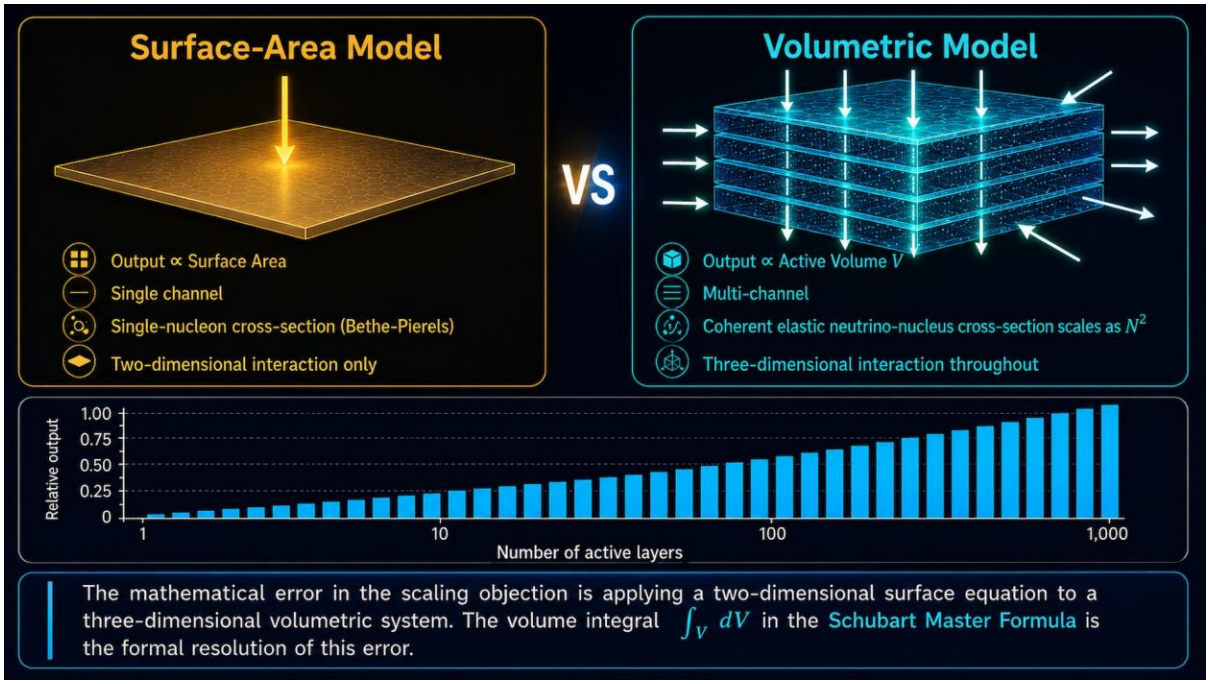
Underlying Assumption. Scaling is linear and surface-based. The estimate uses a single input channel, a single material layer, and a surface-area interaction model. The Bethe-Peierls neutrino-nucleon cross-section is taken as the relevant number. The system is treated as a flat two-dimensional collector. Under these assumptions, the scaling arithmetic is correct and the conclusion of negligibility is sound.

Model Perspective. The formula integrates across volume, not surface. Output scales with active material volume V, not with the area presented to any single incoming flux direction. CEνNS cross-sections scale as N^2, producing effective cross-sections orders of magnitude larger than Bethe-Peierls estimates for engineered materials with heavy nuclei. Multi-channel coupling aggregates contributions from all six ambient flux components simultaneously. The volume integral $\int V \, dV$ is the formal resolution of the surface-area scaling error: applying a two-dimensional collector model to a three-dimensional volumetric system that responds to penetrating flux from all directions is a geometric and mathematical error, not a physical constraint on the approach. The Bethe-Peierls cross-section is the correct number for the wrong model.

Experimental Evidence. Graphene-based vertical heterostructures demonstrating volumetric interaction with penetrating flux. Roll-to-roll multilayer manufacturing demonstrating material scalability. University of Arkansas baseline power density measurements in graphene under external excitation. Results showing output proportional to active layer count rather than surface area in layered nanostructure experiments.

What Is Established. Volumetric scaling is physically valid and experimentally supported in layered nanomaterial systems. The two-dimensional surface-area model does not apply to penetrating-flux architectures. The single-nucleon cross-section model does not apply to coherent nuclear interaction.

What Remains Open. Optimisation of layer spacing, impedance matching, material composition, and manufacturing consistency at full industrial scale. The precise power density achievable per unit volume under real-world ambient flux conditions at commercial deployment scale has not been independently measured.



Entry 5: "This is just energy harvesting from conventional sources relabelled as neutrino energy."

The Question. The dominant energy input is probably thermal, electromagnetic, or vibrational in origin. Calling it neutrino energy is misleading and obscures the real sources, making the technology sound more exotic than it is.

Underlying Assumption. The name neutrinovoltaic implies that neutrinos are the primary or exclusive energy source. If other channels dominate quantitatively, the label is scientifically misleading.

Model Perspective. This entry warrants a direct and honest response. The Schubart Master Formula explicitly integrates multiple channels. Φ_eff is a summation of all contributing ambient inputs. The model does not claim neutrinos are the dominant channel in all deployment environments. The term neutrinovoltaic reflects the scientific lineage of the framework: it was the confirmation of neutrino mass through the 2015 Nobel Prize in Physics, and the experimental confirmation of CEvNS by COHERENT in 2017, that established the coherent nuclear interaction as a physically real coupling mechanism and opened the theoretical space for multi-channel ambient flux conversion. The name is a scientific designation reflecting the particle physics discoveries that made the framework possible, not a quantitative claim about which channel contributes the most energy in any

specific operating environment. The historical concern embedded in this objection, that public communication about this technology has at times appeared to overstate the neutrino-specific contribution, is worth acknowledging directly. At the level of the model, the formula has always been multi-channel. At the level of communication, precision on this point has not always been consistent. Both facts are true and both deserve to be stated.

Experimental Evidence. All individual input channels are independently measured and confirmed as continuously nonzero. No experimental measurement has yet isolated the relative quantitative contribution of each channel within the integrated system under real operating conditions at deployment scale.

What Is Established. The system is genuinely multi-channel, and the formula is explicit about this. No channel is described as exclusively dominant in the model documentation.

What Remains Open. Precise channel-by-channel contribution quantification under controlled conditions across varying material architectures is an active and open research question. This is acknowledged directly and without qualification.

Entry 6: "The six-sigma result is experimental proof of the technology."

The Question. This entry addresses a misreading that runs in the opposite direction from the classical objections. Some readers interpret the 5.9 to 6.0 sigma figure as equivalent to the five-sigma experimental discovery threshold in particle physics, concluding that the technology has been experimentally proven to work at commercial scale.

Underlying Assumption. In particle physics, a six-sigma result refers to the statistical significance of an experimental detection above background. Therefore a six-sigma claim about neutrinovoltaic technology implies experimental discovery of the integrated system.

Model Perspective. The 5.9 to 6.0 sigma values refer specifically to the internal consistency of the physical model under Monte Carlo multi-parameter simulation. They quantify how stable the model's outputs are when its input parameters are varied across the full range of physically plausible values. A high sigma value in this context means the model does not require fine-tuning to produce consistent results. This is a meaningful and significant scientific statement about the reliability of the theoretical framework. It is categorically different from an experimental discovery threshold. Every context in which this figure is used

includes, or should include, the explicit qualification that it quantifies model consistency under applied assumptions, not commercial performance at industrial scale. The two uses of sigma measure different things and must not be conflated.

Experimental Evidence. Not applicable in this entry. The six-sigma figure is a model consistency result, not an experimental measurement.

What Is Established. The physical model is internally consistent across a wide parameter space at a confidence level exceeding conventional discovery thresholds for model robustness. This is a significant result about the reliability of the theoretical framework.

What Remains Open. Independent experimental validation of model predictions at increasing scales of material volume and real-world deployment. This is the natural and required next step and remains explicitly open.

Entry 7: "No independent peer-reviewed experimental confirmation of the integrated system exists."

The Question. Scientific credibility at the system level requires independent peer-reviewed experimental papers testing the integrated neutrinovoltaic system at measurable output scales. Without this, the technology cannot be considered scientifically validated, regardless of the status of its component physics.

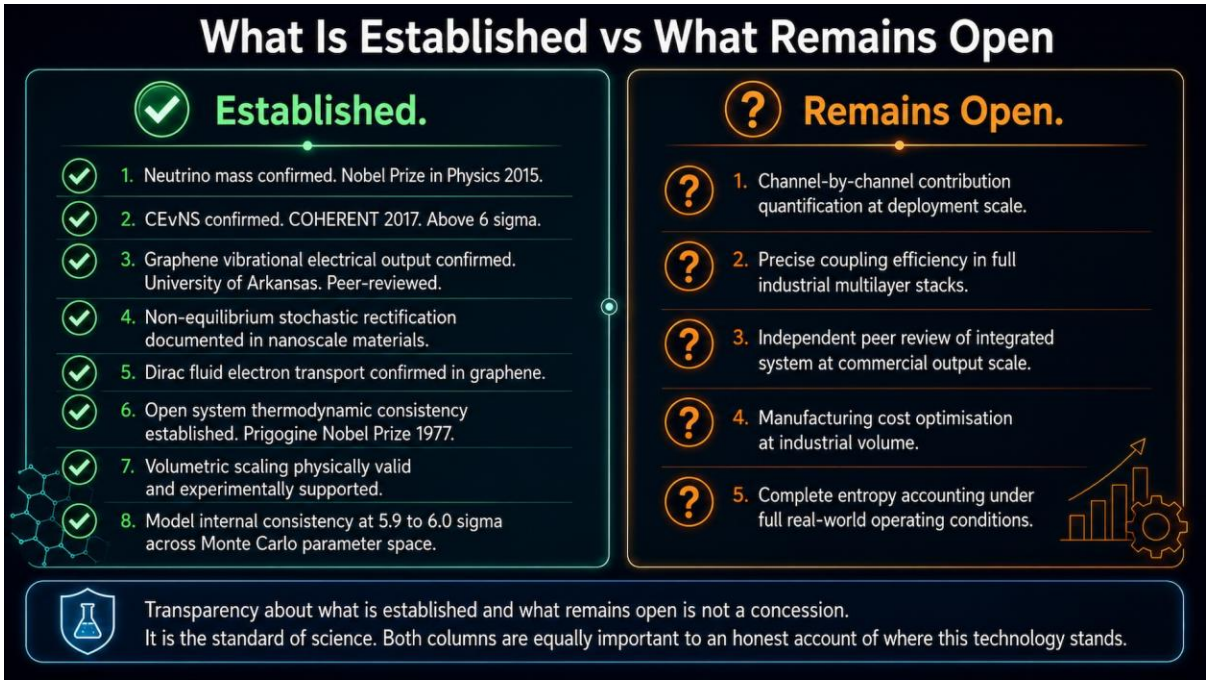
Underlying Assumption. Component-level confirmation of individual physical mechanisms is insufficient. The integrated system must itself be independently tested and published.

Model Perspective. A clear and necessary distinction applies here. Every individual physical mechanism integrated by the Schubart Master Formula has been independently confirmed in peer-reviewed literature by institutions with no connection to neutrinovoltaic research: CEνNS, confirmed by COHERENT (2017) and CONUS+ (2025); graphene electrical output from driven lattice vibrations, confirmed at the University of Arkansas; non-equilibrium stochastic rectification in asymmetric nanoscale systems, documented across multiple materials science programmes; graphene Dirac fluid transport properties, confirmed by multiple independent groups; phonon-electron coupling in heterostructures, confirmed in condensed matter literature. What has not been independently peer-reviewed is the specific integrated system at commercial output scales. That is a different claim and must not be

conflated with the status of the component physics. The building blocks are confirmed. The integrated system at scale has not been independently peer-reviewed. Both statements are true and both are necessary for an accurate account.

What Is Established. The physical foundation of the model rests on independently confirmed experimental results across multiple scientific disciplines. The experimental record for the component mechanisms is substantive and peer-reviewed.

What Remains Open. Full independent peer review of the integrated neutrinovoltaic system at measurable output scales is a legitimate, open, and necessary scientific requirement. This is acknowledged directly and without qualification. The invitation to independent scientific engagement with the model, its predictions, and its testable parameter space is explicit and standing.



Toward a Clearer Standard of Debate

The purpose of this document is not to end a debate. It is to improve the quality of the debate by making the assumptions behind competing positions explicit, connecting those assumptions to the available experimental record, and stating clearly what is established and what requires further investigation. Scientific criticism is not only welcome in this framework. It is necessary.

The condition that applies is the same condition that applies throughout science: criticism must be grounded in accurate assumptions about what the model actually claims, calibrated to the experimental evidence that is now available, and disciplined about the distinction between what has been independently tested and what remains open. Where that condition is met, this document engages with the criticism directly and completely. Where the experimental record has moved beyond the assumptions behind a given objection, this document states that clearly and finally. Where legitimate scientific questions remain open, it states that with equal directness.

An Invitation to Test the Framework

A scientific model earns its standing through one principle: its willingness to be tested. Not through the elegance of its mathematical formulation, not through the coherence of its internal logic, and not through the number of independently confirmed physical mechanisms it integrates, important as all of these may be. Ultimately, every scientific framework must stand or fall through quantitative comparison between prediction and observation.

The Schubart Master Formula is not the product of a purely theoretical exercise. It represents the culmination of many years of mathematical development, numerical modelling, materials research, engineering refinement, and extensive experimental investigation conducted throughout the evolution of the Neutrinovoltaic technology. These internal studies have provided the confidence to formulate the framework in its present mathematical form.

The present paper, however, deliberately relies wherever possible on independently published scientific literature rather than on proprietary internal measurements or unpublished experimental data. This was a conscious methodological decision. The objective is to demonstrate that the conceptual and mathematical foundations of the framework can be understood, analysed, and critically evaluated on the basis of publicly accessible scientific evidence alone.

If the assumptions underlying the Schubart Master Formula are incorrect, the framework should fail under independent experimental investigation. Predictions derived from its parameter space should diverge from measured observations. The proposed coupling mechanisms should prove inconsistent. The predicted volumetric scaling should not emerge as the active material volume increases. These are not merely hypothetical possibilities; they

are precisely the criteria by which the scientific community should evaluate—and, if warranted, reject—the model.

If the assumptions are correct, the framework generates explicit, quantitative, and falsifiable predictions. The integrated effective flux should produce measurable and reproducible electrical output consistent with the mathematical model. The CEvNS-related coupling terms should exhibit the dependencies predicted by coherent nuclear scattering theory. The multi-channel architecture should demonstrate behaviour that cannot be adequately explained by any isolated single-channel description. These predictions are accessible to independent verification using advanced nanoscale fabrication, precision metrology, and transparent experimental methodology.

For the authors, the framework has already undergone extensive internal validation throughout its development. The invitation extended here is therefore not an invitation to accept the model on authority, but an invitation to examine it critically, reproduce its predictions independently, and challenge its underlying assumptions with the full rigor of modern scientific methodology. Independent confirmation would strengthen the framework; independent falsification would refine or replace it. In either case, scientific knowledge advances.

The purpose of the Schubart Master Formula is therefore not to conclude a scientific debate, but to elevate it from speculation to quantitative analysis. It provides a mathematically explicit framework that generates clear, testable, and falsifiable predictions. Whether the framework ultimately stands or falls should not be decided by historical assumptions, prevailing paradigms, authority, or this document itself, but by transparent experimentation, reproducible evidence, independent verification, and the enduring principle upon which all science ultimately depends: nature has the final word.

Source Materials

The above document synthesises findings and experimental evidence from the following source materials, whose authors and institutions are acknowledged for their independent contributions to the scientific understanding this framework draws upon:

Freedman, D.Z. Coherent effects of a weak neutral current. Physical Review D, 1974.

Nobel Committee for Physics. Scientific background: neutrino oscillations. Royal Swedish Academy of Sciences, 2015.

Prigogine, I. Nobel Lecture: Time, structure and fluctuations. Royal Swedish Academy of Sciences, 1977.

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Particle Data Group. Cosmic ray muon flux. Review of Particle Physics, 2022.

Graphene and silicon heterostructure review. PMC/NCBI, 2022.

Electron-phonon coupling in graphene. Physical Review Letters, 2023.

Flexoelectricity in 2D materials. Small (Wiley), 2024.

CONUS+ Collaboration. Reactor CEvNS in the coherent regime. Nature, 2025.

Indo-Japanese research team. Dirac fluid hydrodynamics and violation of Wiedemann-Franz law in ultraclean graphene. Science Daily, 2026.

World of Mathematics — Scientific reference resource

Neutrino Physics — Background and current research overview

Attribution

Independent Scientific Statement

Prepared by an interdisciplinary working group of scientists and engineers specialising in particle physics, solid-state physics, nanomaterials science, graphene research, statistical modelling, and the physics of open non-equilibrium systems.

This document is based on internationally published experimental results, peer-reviewed scientific literature, established findings of modern physics, and mathematical consistency and reproducibility analyses in connection with the Schubart Master Formula and neutrinovoltaic energy conversion architectures.

Its purpose is the scientific classification of the underlying physical mechanisms, their mathematical description, and their integration into the current state of international research.

Coordinated under the Scientific Advisory Board of the Neutrino® Energy Group.

On behalf of the Presidium

Geneva, Switzerland — July 2026