Vacuum Energy, Support, and Measure:

A Conditional Surtea-Austin Reconstruction of Rendering, Light, and Mass

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Abstract

This note gives a conditional Surtea-Austin reconstruction of rendering, light, and mass, rather than a new calculation of particle masses. The construction starts with an energy-bearing vacuum system. Energy-bearing sites are related by declared vectors or directed relations; survival weighting selects the path families that remain represented; the selected paths then construct a support on which measure can persist. Surtea support supplies the formal objecthood layer through which energy can appear as structured rather than merely present. A valuation of interior, closure, and boundary makes exposure measurable without making support itself into mass. Recursive phase transport gives supported structure motion data, survival filtering selects which histories remain represented, and recursive clock structure distinguishes temporal transport from the light-like zero-proper-time limit.

Within this chain, a conditional bridge can be stated more explicitly. A model may represent support-gated vacuum measure as local stress-energy contrast only after an embedding coefficient and conservation rule are declared. Information transport is treated by separating Vopson's information-mass comparator from Austin's carrier-and-recovery route. Once such a conserved stress-energy contrast exists, ordinary gravity, null propagation, frequency-energy bookkeeping, and interaction closure do the subsequent work. Light is rendered as null energy transport rather than rest mass, matter-like representation appears when standard interaction channels produce support-bearing massive excitations, and black-hole assimilation is treated as conserved measure bookkeeping: absorbed light increases the exterior black-hole mass by E_γ/c^2 without giving the photon rest mass. The note marks the status of each step. Standard stress-energy and QFT identities remain standard physics; Surtea support and survival weighting are formal structures; gravitational-wave terminology refers to a conditional exterior readout of embedded time-dependent stress-energy, not a claim that constant motion alone proves gravitational radiation.

Keywords: Vacuum Energy; Mass as Rendering; QFT Stress-Energy; Surtea Support; Survival Weighting; Localisation; Temporal Transport; Information Transport; Light-Matter Closure; Black-Hole Assimilation.
Short title: Vacuum Energy, Support, and Measure.

Reader route. This is deliberately a broad bridge paper, with vacuum energy support as the organising case. The notation and claim-status material fix the discipline for the whole manuscript. Sections 1–2 state the framework, introduce energy sites and relation vectors, and show how survival-selected paths construct Surtea support. Section 3 gives the conditional bridge from support and vacuum measure to local stress-energy contrast, information transport, conserved stress-energy, gravity, null transport, matter-like closure, and black-hole bookkeeping. Sections 4–7 give the standard QFT rendering criterion, worked example, on-shell distinction, graded rendering score, and sector mass bookkeeping. Sections 8–12 apply the same guardrails to black holes, survival weighting, gravitational-wave readout, scale estimates, and vacuum stress-energy. Section 13 states the limits before the conclusion.

Claim-status lock. Standard QFT identities are labelled as standard identities. Surtea support, interior, closure, and boundary are formal definitions. Valuation, boundary exposure, temporal transport, gravity-wave readout, supported-vacuum exchange, and black-hole assimilation are bridge constructions unless their required physical embedding is independently supplied. Sector mass formulae are not new particle-mass predictions; they are standard mass-budget formulae organised by support, transport, survival, and rendering.

Notation and Standing Conventions

The notation is fixed here to avoid shifting meanings between the QFT layer, the rendering layer, and the survival-weighting bridge. In particular, P_C^μ always denotes four-momentum, while Pers_C denotes a persistence score.

Table 1: Notation and standing conventions. The table separates standard physics quantities, rendering definitions, Surtea support terms, and survival-weighting bridge quantities.

Symbol	**Name**	**Meaning and status**
$(\mathcal{M}, g)$	Spacetime background	Standard mathematical setting; no new gravity theory is assumed.
Σ_t, n^μ	Slice and normal	Cauchy or operational equal-time slice and its future-directed normal.
u^μ	Observer four-velocity	Defines the local energy-density reading used in the rendering criterion.
C	Configuration	Field configuration, wave packet, bound state, or effective localised sector being tested for rendering.
$U = (M, D)$	Surtea universe	Underlying set M with partition D; formal support layer before metric structure is added.
$D_i \in D$	D-photon or D-cell	Atomic cell of the partition in Surtea terminology; not an ordinary photon.

Symbol	Name	Meaning and status
e_D, g_D	Etheron and gluon cells	A one-point D-photon is an etheron; a two-point D-photon is a Surtea gluon. These are partition cells, not Standard Model particles.
q_i, ε_i	Energy site and site valuation	A support-level site and its assigned energy measure in an energy-bearing vacuum system; this is a bridge datum.
ν_E	Energy valuation	Added valuation assigning energy measure to cells or sites; distinct from bare topological valuation ν_D.
$\mathcal{G}_E$	Energy-relation graph	Declared network of energy sites and directed relations used to build candidate support.
$\vec{R}_{ij}$	Relation vector	Embedded vector from energy site q_i to q_j, defined only after a frame or embedding is supplied.
$\pi, \mathfrak{S}_{\mathfrak{C}}, \mathcal{K}_*$	Path, selector, and selected path family	A directed path through energy sites, the declared selector, and the survival-selected family of best represented paths.
X_E	Energy-built support	Support constructed from the closure of survival-selected energy sites.
X, X_n	Support	Subset of M, or recursive support at step n, on which objecthood is carried.
$\mathrm{int}_D(X)$	Surtea interior	Largest union of D-cells contained in X.
$\mathrm{cl}_D(X)$	Surtea closure	Smallest union of D-cells containing X.
$\mathrm{bd}_D(X)$	Surtea boundary	$\mathrm{cl}_D(X) \setminus \mathrm{int}_D(X)$; interaction-facing part of support.
$\mathrm{class}_D(X)$	Surtea support class	Classification of X by its interior and closure relation, including lighton, spation, tempon, korpuskon, and undon cases.
$[D]$	D-generated support algebra	Family of unions of D-cells on which a cell measure can be extended.
$\mathfrak{R}_\mu$	Measure codomain	Value system for the Surtea measure filter; not assumed to be $\mathbb{R}_+$.
μ_D	Surtea cell measure	Map $D \to \mathfrak{R}_\mu$, extended to $[D]$; may be signed, oriented, or potential-valued before a magnitude is chosen.
$\bar{\mu}_D$	External or total measure	Measure of $\mathrm{cl}_D(X)$, the closure-borne support content.
$\mathring{\mu}_D$	Internal or proper measure	Measure of $\mathrm{int}_D(X)$, the retained interior content.
$\widetilde{\mu}_D$	Field measure	Measure of $\mathrm{bd}_D(X)$, read as boundary capacity for interaction.
$\widehat{\mu}_D$	Interaction measure	Measure of pairwise closure contact $\mathrm{cl}_D(X) \cap \mathrm{cl}_D(Y)$ for disjoint supports.
ν_D	Nonnegative support valuation	Magnitude or positive-shadow valuation derived from μ_D when an exposure ratio is needed; not part of bare Surtea topology.

Symbol	Name	Meaning and status
$B_D(X)$	Boundary exposure	Valued boundary share $\nu_D(\mathrm{bd}_D\, X)/\nu_D(\mathrm{cl}_D\, X)$, when denominator is nonzero.
$\mathcal{P}_D^{\mathrm{phys}}$	D-physical supports	Proper non-empty supports with non-empty D-boundary; Surtea objecthood condition, not a particle spectrum.
$\chi_X^{(D)}$	Support window	Declared coarse-grained indicator or smearing function associated with $\mathrm{cl}_D(X)$.
Δ_{bd}	Boundary-change diagnostic	Change in boundary structure across a recursive support transition.
Δ_{class}	Class-change diagnostic	Change in Surtea class across a support transition.
Δ_{int}	Interaction diagnostic	Boundary or closure-mediated interaction change between supports.
$\|0\rangle$	Reference vacuum	Background state used for renormalised contrast; choice must be fixed before comparison.
$\|\Psi_F\rangle$	Flux-bearing state	Field state carrying an incoming energy flux relative to the chosen reference vacuum.
$\widehat{T}^{\mu\nu}$	Stress-energy operator	Standard QFT/field-theory object.
$\Delta T_C^{\mu\nu}$	Stress-energy contrast	Renormalised difference between configuration and reference vacuum.
$\Delta T_{X,F}^{\mu\nu}$	Flux-local contrast	Support-windowed stress-energy contrast between $\|\Psi_F\rangle$ and $\|0\rangle$.
Φ_X^{in}	Incoming support flux	Boundary integral of stress-energy entering X, positive by convention for inward energy flow.
$T_R^{\mu\nu}$	Supported recursive-sector stress-energy	Conditional effective stress-energy for unresolved survival-weighted support; must be conserved with the ordinary sector.
Q^ν, Ξ	Exchange current and scalar	Conserved transfer current between supported unresolved structure and represented ordinary stress-energy.
ρ_R, C, α_R	Exchange variables	Effective recursive density, coherence memory, and exchange coefficient in the minimal conserved sector.
$\rho_{\mathrm{vac}}^{\mathrm{ren}}$	Renormalised vacuum density	Vacuum energy after the chosen renormalisation prescription; uniform pieces are not local rendered matter.
$\Delta\varepsilon_C(x;u)$	Energy-density contrast	Observer-measured local contrast, $\Delta T_C^{\mu\nu} u_\mu u_\nu / c^2$, for dimensionful u^μ.
$B_R(x_0)$	Support ball	Candidate localisation region of radius R centred at x_0.
$N_C(t)$	Contrast content	Integral of $\|\Delta\varepsilon_C\|$ over the slice; used only when finite and nonzero.
$L_C(R, x_0; t)$	Localisation fraction	Fraction of contrast contained in $B_R(x_0)$; definition-level quantity.
$\mathsf{Pers}_C(R, x_0; t, \tau_\int)$	Persistence score	Minimum localisation fraction sustained over the interaction time.

Symbol	Name	Meaning and status
$\tau_\int$	Interaction time	Time needed for detection, registration, or causal participation in the chosen context.
Γ_C	Decay width	Standard lifetime parameter for unstable states when such a description is available.
Q_C	Sector closure factor	Model-level factor for whether the sector supplies the relevant conservation, closure, or quantum-number conditions.
D_C	Detector or accessibility factor	Model-level factor for whether a configuration is accessible to the relevant detector, interaction channel, or exterior observer.
I_C	Reversal suppression	Defined measure of how strongly the configuration is prevented from returning to the reference sector.
$\mathcal{R}_C$	Rendering score	Graded support-persistence-registration score; definition, not a new force.
P_C^μ	Four-momentum	Standard total four-momentum of the localised configuration.
$E_C, \mathbf{P}_C$	Energy and spatial momentum	Components of P_C^μ in a chosen frame.
M_C, M_{rend}	Invariant rendered rest mass	$c^{-1}\sqrt{P_C^\mu P_{C\mu}}$ when the four-momentum is time-like.
M_{eff}	Energy-equivalent mass	E/c^2; for light this is not rest mass.
E_γ, ω, f	Photon energy data	$E_\gamma = \hbar\omega = hf$, the energy-frequency channel for light-like transport.
M_{BH}	Black-hole mass	Exterior mass parameter in the black-hole measure package.
ΔM_{BH}	Black-hole mass update	Conserved exterior mass increment from absorbed energy, such as $\eta_{\text{abs}} E_{\gamma,\infty}/c^2$.
$\mathcal{P}_{\text{proc}}, \mathcal{P}_{\text{cons}}$	Black-hole measure maps	Bookkeeping maps for carrier processing and conserved-measure projection; not new forces or hidden dynamical laws.
$(X_{\text{BH}}, \varphi_{\text{BH}}, \mu_{\text{BH}}, S_{\text{BH}})$	Black-hole support tuple	Compact support, transport data, measure package, and exterior persistence of the black-hole object.
Φ, v, h_H, y_f	Higgs quantities	Standard Higgs doublet, vacuum expectation value, Higgs fluctuation, and Yukawa coupling.
$T^{\mu\nu}_{\text{QCD}}$	QCD stress-energy	Standard stress-energy whose localised hadron expectation gives the hadron mass budget.
σ_n	Structured recursive state	$(X_n, \varphi_n, \mu_n, S_n)$.
X_n	Recursive support	Recursive/topological support corresponding to localised rendered support under the bridge.
φ_n	Phase data	Projected phase or transport component.
Θ, Π	Reduced phase variables	Position-like and motion-like coordinates in a smooth phase projection.

Symbol	Name	Meaning and status
J	Projected action norm	$J = \Theta^2 + \ell^2\Pi^2$, the local support of the reduced phase trajectory.
W	Exposure factor	$W = \Theta^2/J$ when $J > 0$; operational loss exposure, not a coordinate-invariant primitive.
Ω^2	Phase-flow coefficient	Bends the reduced (Θ, Π) phase portrait; not by itself spacetime curvature.
$N_R, d\tau_R$	Recursive clock data	Recurrent clock count and calibrated recursive proper time.
μ_n	Measure package	Slot for $E, f, M_{\rm rend}, M_{\rm eff}, P^\mu$, and sector quantum numbers.
$I_{\rm gen}, I_{\rm rec}$	Generated and recovered information	Austin information-transport quantities. Generated information counts available alternatives; recovered information counts what can be read through a carrier and decoder.
$V_{\rm rec}, C_R, I_{\rm min}, \kappa_{\rm rec}$	Recovery data	Detector, sampling, coupling, tolerance, ordering, decoder data, capacity bound, minimum recovered-information threshold, and recovery coupling.
ι_R, χ_I	Recovered-information density and conversion coefficient	Optional information-sector variables. They carry physical weight only through a carrier action, thermodynamic cost, or declared stress-energy embedding.
$E_I, M_I, T_I^{\mu\nu}$	Information energy, mass equivalent, and stress-energy	Vopson/Landauer comparator quantities when an information-energy rule is adopted; not automatic rest mass and not automatic gravity.
S_n, A_i, p_i	Survival quantities	Survival weight, accumulated loss, and normalised represented measure.
$\Gamma W, \Lambda_{\rm surv}$	Survival-loss rate	History-selection rate in survival weighting; not a Standard Model mass term and not $\Lambda_{\rm CC}$.
$\Lambda_{\rm CC}$	Cosmological constant	Spacetime curvature source; distinct type and dimensions from $\Lambda_{\rm surv}$.

Standing assumptions. All support and persistence thresholds are fixed before they are used. The invariant-mass formula is used only for localised configurations with finite total stress-energy and a well-defined total four-momentum. Sector decompositions may be scheme-dependent, but the total stress-energy and invariant mass are the quantities that carry the claim. Gauge-dependent subdivisions are treated as diagnostic budgets, not independent observables.

Table 2: Parameter audit. Examples are kept in breakable text so the table does not intrude into adjacent columns.

Quantity class	Examples and status in this reconstruction
Standard imports	Examples include c, $\hbar$, $T^{\mu\nu}$, P^μ, m_f, m_W, m_Z, Γ_C, QCD stress-energy, and trace-anomaly terms. These are used with their ordinary sector meanings. Rendering does not alter these definitions or infer their numerical values.

Quantity class	Examples and status in this reconstruction
Fitted or measured sector inputs	Examples include y_f, v, hadron masses, decay widths, resonance lifetimes, and detector thresholds. These must be supplied independently by Standard Model sectors, experiment, or the chosen effective model.
Internal definitions	Examples include $\Delta T_C^{\mu\nu}$, $\Delta\varepsilon_C$, N_C, L_C, Pers_C, $\mathcal{R}_C$, I_C, Q_C, D_C, $M_{\rm eff}$, and $M_{\rm rend}$. These classify support, persistence, closure, accessibility, and mass-equivalent bookkeeping.
Free contextual choices	Examples include R, x_0, ϵ_L, ϵ_P, $\tau_\int$, $E_{\min}$, Q_C, and D_C. These are fixed before classification. They encode the experimental or theoretical context and cannot be tuned after the result.
Bridge and conjectural quantities	Examples include the energy sites, the Surtea measure-filter family μ_D, relation vectors, selected path families, structured recursive states, supported stress-energy, exchange currents, black-hole measure maps, survival-loss terms, β_M, and $\mathcal{F}$. These are used only under declared bridge assumptions. The coefficients α_R, β_M, and $\mathcal{F}$ belong to model specification unless independently fixed.
Information-transport quantities	Examples include $I_{\rm gen}$, $I_{\rm rec}$, $V_{\rm rec}$, C_R, ι_R, χ_I, E_I, M_I, and $T_I^{\mu\nu}$. These enter either through a physical carrier, a thermodynamic information cost, or a declared information-sector action. They are not used as automatic mass sources.

1 Problem and Status of the Reconstruction

Emerson King's *Mass as Rendering* proposes a structural unification of three familiar mass accounts: Higgs rest mass, QCD binding mass, and the relativistic mass-energy contribution of localised systems [1]. This note reads that unification through the broader Surtea-Austin chain. The intended construction begins with an energy-bearing vacuum system. Energy sites are assigned measure, directed relations between sites are read as vectors after a frame or embedding is supplied, survival weighting selects the best represented paths through those relations, and the selected paths construct the support on which objecthood can be read. Boundary valuation then makes exposure measurable. Recursive phase transport gives supported structure motion data. Temporal transport appears when support, transport, measure, and survival remain coherent across recursive depth. Light is rendered as null energy propagation through frame limits. Matter-like histories appear when standard interactions close energy into support-bearing massive excitations. A black hole is the limiting support case in which exterior recovery of the carrier history fails while conserved measure updates the black-hole package.

The main claim is that mass-facing readout is a vacuum-energy, relation-vector, support-measure-survival reconstruction. Standard physics supplies sector measures and conservation laws. The Surtea-Austin bridge classifies how energy-bearing relations construct support, how survival weighting selects represented paths, and when those supported measures become persistent, transported, and registrable.

The unification is not that all these mechanisms are dynamically identical. They are not. Yukawa coupling to the Higgs vacuum, non-perturbative confinement in QCD, ordinary invariant mass of a bound system, pair production, and black-hole mass assimilation are different physical mechanisms. The common form is that energy becomes matter-facing only when it is supported, transported, measured, and persistent under the relevant conservation and survival conditions.

$$\text{mass mechanism} \neq \text{rendering criterion.}$$

The mass mechanism supplies the sector-specific source or budget, such as a Yukawa mass term, QCD confinement energy, bound-system stress-energy, photon frequency energy, pair-production closure, or horizon absorption. The rendering criterion classifies when the relevant energy-bearing configuration has support, persistence, accessibility, and measure attachment.

Read conservatively, the proposal introduces no new field, force, or modified mass law. Its novelty is a unifying grammar for what standard physics already treats across several sectors: Higgs rest mass, QCD confinement mass, bound-system mass, light-to-matter conversion, horizon particle creation, and gravitational sourcing. The primary physics remains the Standard Model, quantum field theory in curved spacetime, and general relativity. The framework is therefore strongest when treated as an interpretive and modelling structure unless an additional quantitative bridge law is supplied.

The bridge to standard physics is direct. Support corresponds to local stress-energy contrast carried by a finite region. Exposure corresponds to openness to decay, escape, annihilation, leakage, or capture channels. Valuation corresponds to measurable sector content, including energy, frequency, invariant mass, charge, and momentum. Persistence corresponds to closure across ordinary time or recursive depth. Matter is therefore not vacuum as such, but vacuum activity with support and duration, plus the standard sector mechanism that supplies mass or mass-equivalent measure where relevant.

This note makes that claim mathematically explicit under five standing disciplines. **Standard identities** are used in their ordinary sense: the stress-energy tensor $T^{\mu\nu}$, four-momentum P^{μ}, and invariant mass $M^2c^2 = P^{\mu}P_{\mu}$ carry the usual field-theoretic meanings. **Definitions** introduce rendering as localised energy-density contrast with persistence over an interaction or detection time, with a graded rendering functional for intermediate cases between vacuum fluctuation and stable particle. **Sector reconstructions** express Higgs, QCD, bound-system, and light-like cases as sector mass budgets; they are not new calculations of the electron mass, proton mass, or any other particle mass. **Bridge postulates** state where the standard mass-equivalent bookkeeping lives inside a structured recursive state and how rendering is read through support, recurrence, and survival. A bridge postulate is not an empirical success by itself. **Derived consequences** are algebraic or logical consequences within the declared assumptions. **Future bridges** are reserved for optional extensions whose coefficients, conservation laws, and falsifiers have not yet been fixed.

Throughout, c and $\hbar$ are displayed when they clarify units. Natural units $c = \hbar = 1$ may be recovered by suppressing them.

Table 3: Claim-status table. Each claim is stated with its epistemic status, required input, and failure condition.

Claim	**Status**	**Input required**	**Falsifier or failure condition**
Stress-energy defines the conserved energy and momentum budget of a localised configuration.	Standard identity	A field theory with a well-defined $T^{\mu\nu}$, reference state, and integration slice.	No finite conserved four-momentum exists for the configuration being classified.

Claim	Status	Input required	Falsifier or failure condition
Invariant rest mass follows from total four-momentum when the total four-momentum is time-like.	Standard identity	A finite total P^μ and a time-like sector.	$P^\mu P_\mu \leq 0$, or the object is not a finite isolated system.
Surtea support supplies formal objecthood before physical measure is attached.	Formal definition	A partitioned universe $U = (M, D)$, support X, and the induced interior, closure, and boundary.	Support is mistaken for energy or mass without an added physical measure.
Energy relations can construct candidate support.	Conditional bridge definition	Energy sites q_i, site valuations ε_i, a declared embedding or frame, relation vectors $\vec{R}_{ij}$, selector $\mathfrak{S}_{\mathfrak{C}}$, and a survival functional fixed before comparison.	The energy valuation, relation graph, selector, or path-selection rule is chosen after the desired support is known.
Boundary exposure $B_D(X)$ is measurable once a valuation is supplied.	Conditional bridge	A valuation ν_D on closures and boundaries with nonzero denominator.	ν_D is not specified, or the denominator vanishes.
The information filter decomposes support measure into total, proper, boundary, and interaction channels.	Formal measure definition	A cell measure $\mu_D : D \to \mathfrak{R}_\mu$, its extension to $[D]$, and a declared magnitude or positive cone when ratios are required.	Signed or potential-valued measure is treated as a probability, energy, or force without the required projection and physical embedding.
An energy flux becomes local stress-energy contrast only when measured against a reference vacuum and retained or converted inside a support.	Standard contrast plus bridge condition	A flux-bearing state $\lvert\Psi_F\rangle$, reference vacuum $\lvert 0\rangle$, support window $\chi_X^{(D)}$, and fixed persistence threshold.	The flux merely passes through with no support energy above threshold over τ_f.
Information transport enters through physical carriers, thermodynamic costs, or a declared information-sector action.	Comparator plus conditional bridge	A recovery vector V_{rec}, carrier stress-energy, channel capacity, or independently specified S_I and $T_I^{\mu\nu}$.	Abstract information is treated as gravitating or mass-bearing without a carrier, cost, action, or conservation rule.

Claim	**Status**	**Input required**	**Falsifier or failure condition**
A declared supported effective sector may contribute to gravity only when represented as conserved stress-energy.	Conditional stress-energy bridge	A support window $\chi_X^{(D)}$, an independently fixed embedding into $T_R^{\mu\nu}$, and covariant conservation with the ordinary sector.	The bridge supplies no conserved stress-energy contrast, or the same observed gravity is inserted as an input.
Rendering classifies localised persistent stress-energy contrast.	Definition	Fixed R, x_0, ϵ_L, ϵ_P, $\tau_\int$, and $E_{\min}$ before classification.	Thresholds are chosen after seeing the result, or localisation and persistence fail.
Higgs, QCD, bound-system, and photon formulae supply sector bookkeeping.	Standard-sector reconstruction	Accepted sector dynamics, measured or fitted couplings where relevant, and conservation laws.	The sector inputs are treated as predictions of the rendering criterion alone.
Survival weighting ranks represented histories after sector mass or energy-equivalent data have already been supplied.	Conditional embedding	A structured state $\sigma_n = (X_n, \varphi_n, \mu_n, S_n)$ and bridge postulates R1–R3.	μ_n is treated as a mass generator rather than a measure package.
Moving support can have an exterior gravitational-wave readout only under the standard multipole condition.	Conditional GR embedding	Time-dependent embedded stress-energy with the required changing multipole structure.	Constant inertial motion is presented as sufficient for gravitational radiation.
Light can add mass to a black hole without acquiring photon rest mass.	Standard conservation plus bridge bookkeeping	Exterior photon energy $E_{\gamma,\infty}$, absorption fraction, and black-hole measure update.	Energy-equivalent mass is confused with invariant photon rest mass, or exterior carrier recovery is asserted after horizon crossing.
Survival-coupled matter weighting could become a future matter law.	Future bridge	Independently fixed β_M, $\mathcal{F}$, observables, and falsifiers.	Coefficients are adjusted after the fact, or no independent test is supplied.

Table 4: Algebraic reduction and claim-status audit. The table states what remains after the displayed expressions are reduced to their inputs.

Claim	**Substitution or reduction**	**Result**	**Claim status**
Boundary exposure	$\mathcal{B}_X = B_D(X) = \nu_D(\mathrm{bd}_D\, X)/\nu_D(\mathrm{cl}_D\, X)$.	The same definition under a support-gate symbol.	Definition.
Surtea information filter	Eqs. (23)–(24) define total, proper, boundary-field, and interaction measures.	Support measure is separated into total, proper, boundary-field, and interaction channels.	Formal measure decomposition.
Selector	$\mathfrak{S}_{\mathfrak{C}}(\pi) = 1$ only when energy, admissibility, survival, and mismatch conditions are met.	Selection is a declared operator, not an after-the-fact preference.	Conditional definition.
Energy-built support	$X_E = \mathrm{cl}_D\big(\bigcup_{\pi\in\mathcal{K}_*}\{q_i : q_i \in \pi\}\big)$.	Support follows from pre-declared energy sites, relation graph, selector, and survival rule.	Conditional definition.
Flux-local contrast	$\Delta T^{\mu\nu}_{X,F} = \chi^{(D)}_X(\langle\Psi_F\lvert\widehat{T}^{\mu\nu}\rvert\Psi_F\rangle - \langle 0\lvert\widehat{T}^{\mu\nu}\rvert 0\rangle_{\mathrm{ren}})$.	Local contrast is a support-windowed difference from the reference vacuum.	Standard contrast definition.
Austin recovered information	$I_{\mathrm{rec}}(t_{\mathrm{obs}} \mid V_{\mathrm{rec}}) \le C_R t_{\mathrm{obs}}$.	Recovery is bounded by carrier, detector, coupling, sampling, ordering, and decoder data.	Information-transport definition.
Vopson information mass comparator	$E_I = N_{\mathrm{bit}} k_B T_L \ln 2,\ M_I = E_I/c^2$ when the thermodynamic rule is adopted.	Information contributes as an energy-equivalent cost only under the specified physical rule.	Optional comparator.
Information stress-energy bridge	$T^{\mu\nu}_I = -2(\sqrt{-g})^{-1}\delta S_I/\delta g_{\mu\nu}$.	A gravitating information sector needs an action, support, units, couplings, and conservation rule.	Future bridge unless fixed.
Black-hole measure maps	$\mathcal{P}_{\mathrm{proc}}(\mu_{\mathrm{in}}) = \mu_{\mathrm{out}} + \mu_{\mathrm{abs}}$, then $\mathcal{P}_{\mathrm{cons}}(\mu_{\mathrm{abs}})$.	The first map splits a carrier package; the second projects the absorbed part onto conserved exterior updates.	Bookkeeping maps.
Supported effective source	$T^{\mu\nu}_{R,X} = \mathfrak{F}^{\mu\nu}_R[\rho^{\mathrm{ren}}_{\mathrm{vac}}, \chi^{(D)}_X, \mathcal{B}_X, C_X, \varphi_X, g]$.	No prediction until $\mathfrak{F}^{\mu\nu}_R$ and coefficients are fixed independently.	Bridge placeholder.
Rendered mass	$M_{\mathrm{rend}} = c^{-1}\sqrt{P^{\mu}_C P_{C\mu}}$.	Standard invariant mass for a time-like total four-momentum.	Standard identity.

Claim	Substitution or reduction	Result	Claim status
Higgs rendered rest energy	$E = m_f c^2 = y_f v c^2/\sqrt{2}$.	Uses imported y_f and v.	Standard-sector bookkeeping.
QCD rendered mass	$M_{\text{rend}}^{\text{QCD}} = c^{-2}\langle\int T_{\text{QCD}}^{00}\mathrm{d}^3x\rangle$.	The hadron mass budget rewritten in rendering notation.	Standard reconstruction.
Survival weighting	$p_i = \mathrm{e}^{-A_i}/\sum_j \mathrm{e}^{-A_j}$.	Normalised represented history weight.	Definition.
Future matter weighting	Add $\beta_M \mathcal{F}(M_{\text{eff}}, X, \varphi)$.	Free extra bridge term unless fixed before data comparison.	Future work.

2 Surtea Support as Structured Availability

The earlier draft began too late, at stress-energy. The Surtea-Austin reading begins one layer earlier. It asks how energy relations in an energy-bearing vacuum system can construct a support before that support is interpreted as a physical object [2, 3, 4, 5]. Let

$$U = (M, D) \tag{1}$$

be a Surtea universe, where M is an underlying set and D is a partition of M. Following the vocabulary fixed in the *Surtea-Austin Triangle* bridge note, the elements of D are D-photons or D-cells [2, 3]. This is Surtea's cellular terminology. A D-photon is an atom of the partition, not a quantum-electrodynamic photon. If a D-photon contains exactly one material point it is called an etheron, and if it contains exactly two material points it is called a Surtea gluon. These names belong to the partition-topological layer; they must not be confused with Standard Model particles.

2.1 Energy sites, relation vectors, and survival-selected support

The bridge begins only in a system that contains an energy measure. Let ν_E be a declared energy valuation on cells or coarse-grained sites, and let

$$\mathcal{V}_E = \{q_i \in M : \varepsilon_i = \nu_E(D(q_i)) > 0\} \tag{2}$$

be the set of energy-bearing sites, where $D(q_i)$ denotes the D-cell containing q_i. These sites are not particles. They are support-level locations at which the vacuum system carries nonzero measure in the chosen valuation.

After an embedding or observational frame

$$\iota : M \longrightarrow \Sigma_t \tag{3}$$

is fixed, a relation between two energy sites can be represented by the vector

$$\vec{R}_{ij} = \iota(q_j) - \iota(q_i), \qquad \vec{V}_{ij} = \kappa_{ij}\vec{R}_{ij}. \tag{4}$$

The coefficient κ_{ij} is the declared coupling, contrast, or transport weight between the two sites. It may depend on energy valuation, boundary exposure, phase compatibility, or a

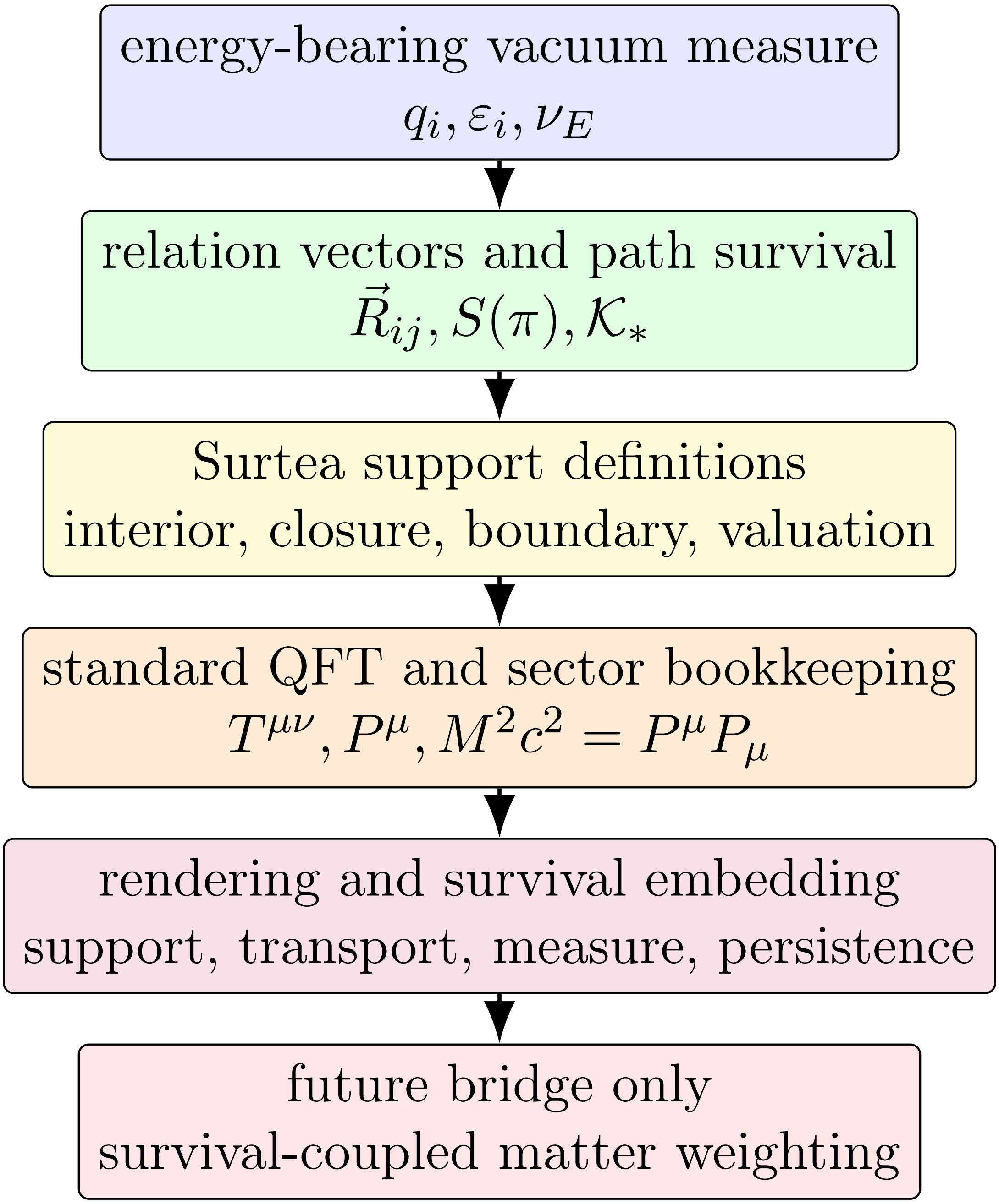

Figure 1: Claim architecture stack. The paper starts with energy-bearing vacuum measure, constructs support through relation vectors and survival selection by the declared selector, then embeds standard mass bookkeeping. It does not calculate numerical particle masses from survival weighting alone.

sector model, but it must be fixed before the support is classified. The resulting directed relation system is

$$\mathcal{G}_E = (\mathcal{V}_E, \mathcal{A}_E), \qquad (i,j) \in \mathcal{A}_E \Longleftrightarrow \kappa_{ij} \neq 0. \tag{5}$$

This is the precise sense in which relationships between energy sites are read as vectors. The vector system does not yet prove a force law. It is the bridge structure from energy-bearing vacuum measure to candidate support.

A directed path

$$\pi = (q_{i_0}, q_{i_1}, \ldots, q_{i_m}) \tag{6}$$

has a survival action

$$A(\pi) = \sum_{r=0}^{m-1} \left[\Gamma_{i_r i_{r+1}} W_{i_r i_{r+1}} \Delta\tau_{i_r i_{r+1}} + \lambda\, \mathcal{C}_{i_r i_{r+1}}\right], \qquad S(\pi) = \exp[-A(\pi)]. \tag{7}$$

Here ΓW is the survival-loss term, and $\mathcal{C}$ is any declared mismatch cost for phase, boundary, frame, or sector compatibility. The missing formal object is the selector. For a declared selection context

$$\mathfrak{C}_{\mathrm{sel}} = (\nu_E, \iota, \kappa, A, \epsilon_S, E^{\pi}_{\mathrm{min}}, C_{\mathrm{max}}, \mathcal{A}_E)$$

define

$$\mathfrak{S}_{\mathfrak{C}_{\mathrm{sel}}}(\pi) = 1 \tag{8}$$

only when all of the following are true:

$$\pi \text{ is a directed path in } \mathcal{G}_E, \tag{9}$$

$$E(\pi) = \sum_{q_i \in \pi} \varepsilon_i \geq E^{\pi}_{\mathrm{min}}, \tag{10}$$

$$A(\pi) < \infty, \qquad \mathcal{C}(\pi) = \sum_{r=0}^{m-1} \mathcal{C}_{i_r i_{r+1}} \leq C_{\mathrm{max}}, \tag{11}$$

$$S(\pi) \geq (1 - \epsilon_S) \sup_{\pi' : a \to b} S(\pi'). \tag{12}$$

Otherwise $\mathfrak{S}_{\mathfrak{C}_{\mathrm{sel}}}(\pi) = 0$. The selector is a modelling rule, not a new physical force. It must be declared before support construction; if its thresholds are adjusted after the desired support is known, the bridge has become a fitted restatement.

For endpoints a, b, the selected family is then

$$\mathcal{K}_*(a,b) = \left\{\pi : a \to b \mid \mathfrak{S}_{\mathfrak{C}_{\mathrm{sel}}}(\pi) = 1\right\}. \tag{13}$$

The word "best" therefore means best represented under a pre-declared selector and survival functional. It does not mean selected after the fact.

The support built by those energy relations is

$$X_E(a,b) = \mathrm{cl}_D \left(\bigcup_{\pi \in \mathcal{K}_*(a,b)} \{q_i : q_i \in \pi\} \right). \tag{14}$$

Equation (14) is the constructive core of the paper. Vacuum energy measure supplies energy-bearing sites. Relation vectors supply directed structure between those sites.

Survival weighting selects the represented path family. The closure of those selected sites is the Surtea support on which boundary, valuation, light-like propagation, and mass-facing bookkeeping can later be read.

The following chart gives the whole construction as an illustrative sequence. It is a visual reading order, not a logical proof and not a replacement for the equations above.

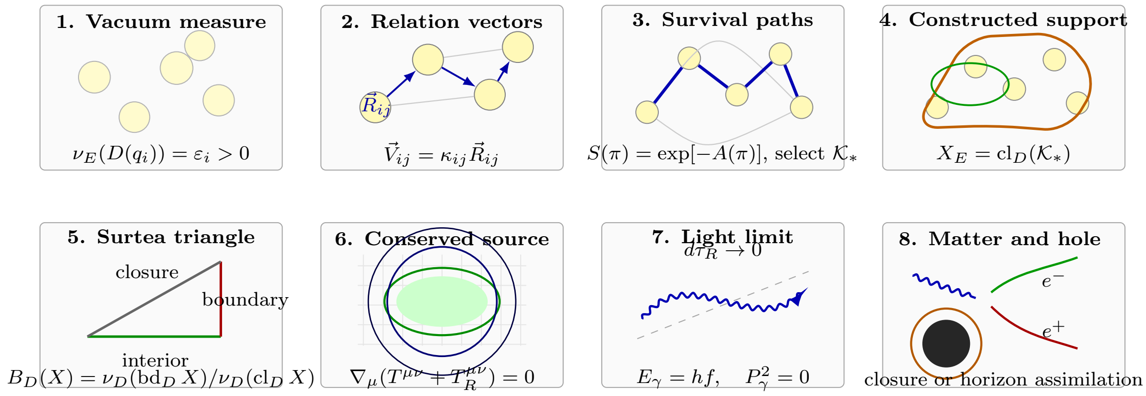

Figure 2: Illustrative construction chart. The panels read the whole bridge as a staged picture: energy-bearing vacuum measure, relation vectors, survival selection, constructed support, Surtea boundary valuation, conserved stress-energy, light-like propagation, and finally matter-like closure or black-hole measure assimilation. The chart is illustrative, not a flowchart and not an additional proof.

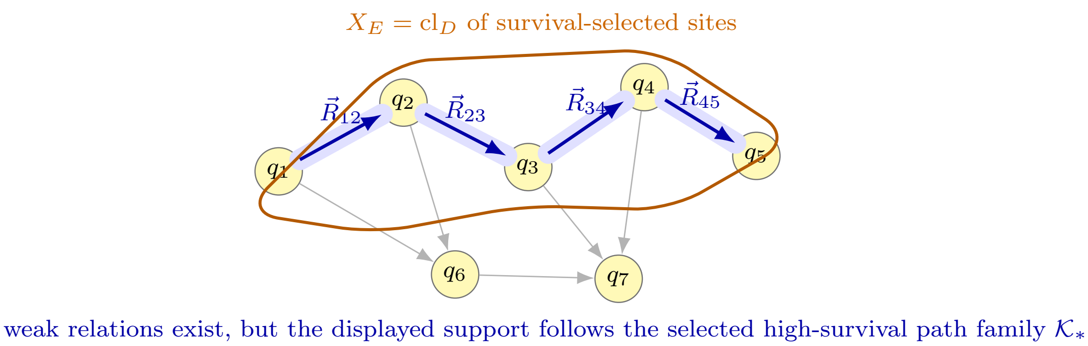

Figure 3: Energy sites and survival-selected support. Energy-bearing sites are connected by declared relation vectors. Survival weighting selects the path family that remains represented, and the Surtea closure of the selected sites constructs the support.

A support $X \subseteq M$ is not yet a physical object in the full sense. It is the formal place where objecthood can be read. Relative to D, define

$$\mathrm{int}_D(X) = \bigcup\{D_i \in D : D_i \subseteq X\}, \tag{15}$$

$$\mathrm{cl}_D(X) = \bigcup\{D_i \in D : D_i \cap X \neq \varnothing\}, \tag{16}$$

$$\mathrm{bd}_D(X) = \mathrm{cl}_D(X) \setminus \mathrm{int}_D(X). \tag{17}$$

The interior is what the support fully contains. The closure is what the support touches. The boundary is the interaction-facing difference between the two. None of these definitions requires a metric, a force law, a mass, or a smooth manifold.

The same interior-closure data also define Surtea's support classes [2, 4]. In the present manuscript the class names are used only as support diagnostics. A lighton is a direct union of D-photons, open and closed in the partition topology, so its boundary is empty. A spation is sparse and non-dense, with empty interior and non-total closure. A tempon is dense but not sparse, with non-empty interior and total closure. A korpuskon is the ordinary boundary-bearing case with non-empty interior and non-total closure. An undon is both sparse and dense, with empty interior and total closure, so it is maximally boundary-exposed. The exceptional total and null lighton limits are $X = M$ and $X = \varnothing$. This vocabulary is useful because a recursive support can change not only its boundary size, but also its Surtea class.

Table 5: Surtea support classes used as diagnostics in this reconstruction.

Surtea name	**Support condition**	**Role in this note**
D-photon	Atomic cell of the partition D.	Basic cellular unit from which support, interior, closure, and boundary are read.
Etheron	One-point D-photon.	Partition-cell limit, not a physical ether substance.
Gluon	Two-point D-photon.	Surtea cell name, not a QCD gluon.
Lighton	Boundary-free union of D-photons, with empty boundary.	Zero-boundary support limit.
Spation	Sparse, non-dense support.	Boundary-bearing support with empty interior and non-total closure.
Tempon	Dense, non-sparse support.	Support with non-empty interior and total closure.
Korpuskon	Non-empty interior and non-total closure.	Ordinary boundary-bearing support class.
Undon	Sparse and dense support.	Maximal boundary-exposure support class.

Write the support class as

$$\mathrm{class}_D(X) \in \{\mathrm{lighton}, \mathrm{spation}, \mathrm{tempon}, \mathrm{korpuskon}, \mathrm{undon}\} \quad \text{up to the exceptional total and null limits.} \tag{18}$$

Across a recursive transition $X_n \mapsto X_{n+1}$, class change can be recorded by the diagnostic

$$\Delta_{\mathrm{class}}(n) = \begin{cases} 0, & \mathrm{class}_D(X_{n+1}) = \mathrm{class}_D(X_n), \\ 1, & \mathrm{class}_D(X_{n+1}) \neq \mathrm{class}_D(X_n), \end{cases} \tag{19}$$

or by any pre-declared distance on the class set. This is the class diagnostic used later in the Surtea-Austin survival bridge.

2.2 The information filter as Surtea measure decomposition

The support layer needs a measurement grammar before it can be used as an information filter. Let

$$[D] = \left\{ \bigcup_{i \in I} D_i : \ I \text{ is an admissible index set} \right\} \tag{20}$$

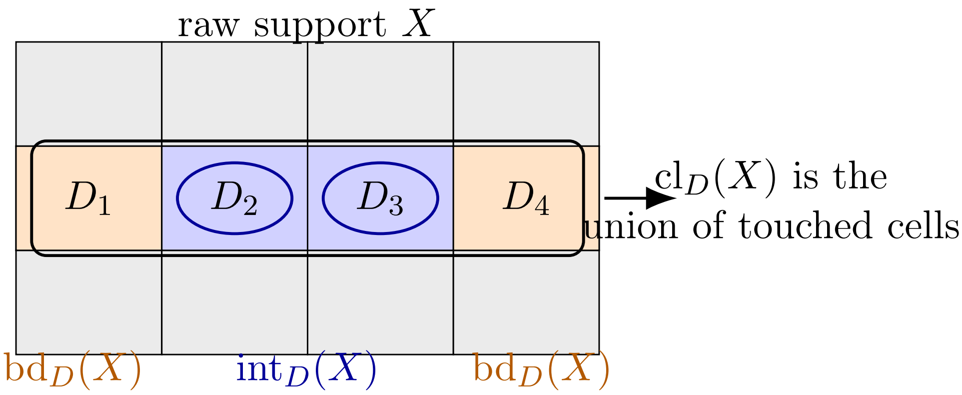

Figure 4: Surtea support decomposition. The support has an interior and an interaction-facing boundary relative to the partition D; this is a formal availability structure, not yet physical mass.

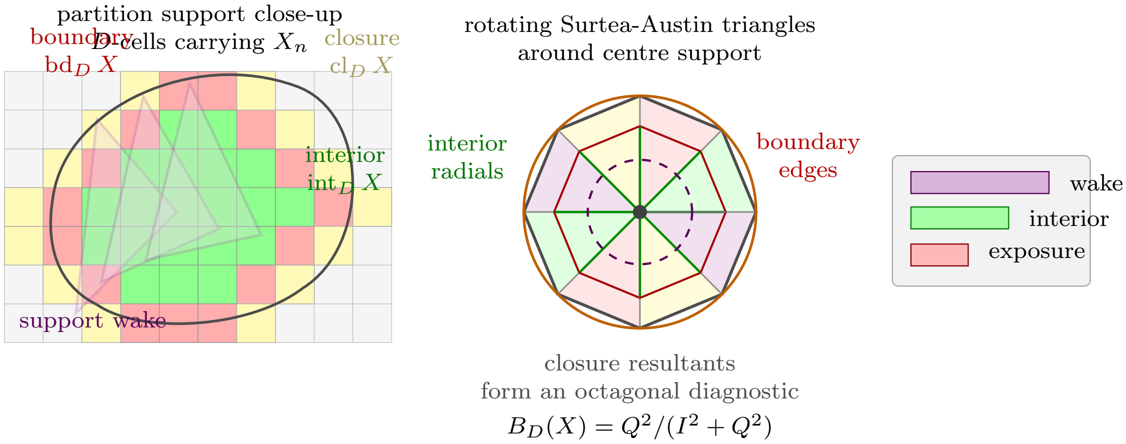

Figure 5: Surtea-Austin triangle diagnostic. The picture reads a single support through partition cells, separates interior, boundary, closure, and wake, then rotates the valued triangle around a centre point so the repeated diagnostic forms an octagonal support wheel. The rotating triangles are a diagnostic of support, not the physical object itself.

be the family of supports generated by unions of D-cells. Start with a cell measure

$$\mu_D : D \to \mathfrak{R}_\mu, \qquad \mu_D : [D] \to \mathfrak{R}_\mu, \tag{21}$$

where the same symbol denotes the extension to generated supports. The codomain $\mathfrak{R}_\mu$ is not assumed to be $\mathbb{R}_+$. It may be signed, oriented, potential-valued, or otherwise richer than a nonnegative measure, provided its algebra is declared before use. For disjoint finite unions one may impose additivity,

$$\mu_D\left(\bigcup_{j=1}^{k} A_j\right) = \sum_{j=1}^{k} \mu_D(A_j), \qquad A_j \in [D], \qquad A_i \cap A_j = \varnothing \ (i \neq j), \tag{22}$$

when the chosen valuation system supports the sum.

For any $X \subseteq M$, define the four measure readouts

$$\begin{aligned} \bar{\mu}_D(X) &:= \mu_D(\mathrm{cl}_D\, X), \qquad \mathring{\mu}_D(X) := \mu_D(\mathrm{int}_D\, X), \\ \widetilde{\mu}_D(X) &:= \mu_D(\mathrm{bd}_D\, X). \end{aligned} \tag{23}$$

Here $\bar{\mu}_D$ is the external or total measure, $\mathring{\mu}_D$ is the internal or proper measure, and $\widetilde{\mu}_D$ is the field measure or capacity of interaction carried by the boundary. For two disjoint supports, the pairwise interaction measure is

$$\begin{aligned} \widehat{\mu}_D(X, Y) := \mu_D(\mathrm{cl}_D\, X \cap \mathrm{cl}_D\, Y), \\ X \cap Y = \varnothing. \end{aligned} \tag{24}$$

This is defined only for disjoint supports because it is meant to measure closure-level contact, not self-overlap.

This decomposition is the support-side information filter. The total measure records what the support is externally carrying. The proper measure records what is interiorly retained. The field measure records how much of the support is exposed for interaction. The pairwise interaction measure records how two distinct supports become mutually measurable through closure contact. In this precise sense, light-like probing can measure everything only by entering the boundary and interaction channels supplied by $\widetilde{\mu}_D$ and $\widehat{\mu}_D$, then carrying recoverable information through an energy-bearing field.

The earlier nonnegative support valuation is recovered only after choosing a magnitude or positive-shadow map

$$\nu_D(A) := \|\mu_D(A)\|_\mu, \qquad A \in [D], \tag{25}$$

or another declared projection from $\mathfrak{R}_\mu$ to nonnegative readouts. When $\nu_D(\mathrm{cl}_D\, X) > 0$, the boundary exposure ratio is

$$B_D(X) = \frac{\nu_D(\mathrm{bd}_D\, X)}{\nu_D(\mathrm{cl}_D\, X)}. \tag{26}$$

This is the first place where support can make energy appear to have structure. The support does not create energy. Rather, it supplies interior, closure, and boundary relations through which an attached measure package can be distributed, exposed, coupled, and recovered.

In a recursive state, the support component is therefore necessary but not sufficient:

$$X_n \neq \sigma_n, \qquad \sigma_n = (X_n, \varphi_n, \mu_n, S_n). \tag{27}$$

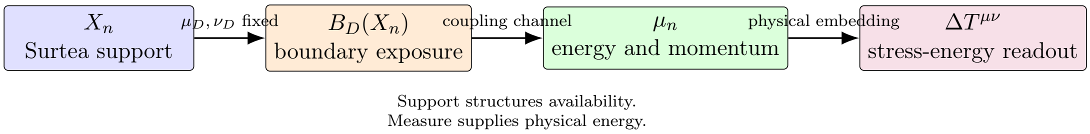

Figure 6: Support-to-energy-structure bridge. Boundary exposure can organise where measure data couple, but it is not by itself a mass or stress-energy source.

The support X_n says where the state is available. The phase component φ_n says how it is transported. The measure package μ_n says what physical quantities, including energy, momentum, frequency, mass equivalent, charge, or spin, are attached. The survival weight S_n says how strongly that history remains represented. The thesis of this paper is that rendering lives in the coupled chain, not in any one slot alone:

$$\begin{aligned}\text{energy-bearing vacuum} &\longrightarrow \text{energy sites} \longrightarrow \text{relation vectors} \longrightarrow \text{survival-selected paths}\\ &\longrightarrow \text{constructed support} \longrightarrow \text{boundary exposure} \longrightarrow \text{transport} \longrightarrow \text{measure}\\ &\longrightarrow \text{survival} \longrightarrow \text{rendered matter-like readout.}\end{aligned}$$

3 Conditional Bridge from Supported Vacuum Measure to Gravity, Light, and Matter

The stronger Surtea-Austin proposal can now be stated without losing the claim-status discipline. Bare support does not make gravity. Uniform vacuum energy does not automatically become a local object. A support-gated vacuum measure is gravitationally active only in a model that represents it by a conserved effective stress-energy tensor. In the intended construction the support is not simply assumed; it is built from energy sites, relation vectors, the declared selector, and survival-selected path families as in Eq. (14). Once this bridge is declared, the later steps are standard: stress-energy sources curvature, curvature shapes null transport, null transport carries frequency-energy, and interaction closure can convert that energy into matter-like field excitations.

3.1 Support gate

Surtea's formal objecthood condition for interaction-bearing supports is

$$\mathcal{P}_D^{\mathrm{phys}} = \{X \subset M : \ X \neq \varnothing, \ X \neq M, \ \mathrm{bd}_D(X) \neq \varnothing\}. \tag{28}$$

For the energy-built case, the candidate support is X_E. It is admitted to the physical-support channel only if

$$X_E \in \mathcal{P}_D^{\mathrm{phys}} \quad \Longleftrightarrow \quad X_E \neq \varnothing, \quad X_E \neq M, \quad \mathrm{bd}_D(X_E) \neq \varnothing. \tag{29}$$

This condition says that the selected energy paths have constructed a proper boundary-bearing support. It does not yet say that the support is massive, light-like, or gravitationally active. For two disjoint supports, the Surtea interaction diagnostic is carried by closure or boundary contact:

$$A \, \mathcal{I}_D \, B \quad \Longleftrightarrow \quad \mathrm{cl}_D(A) \cap \mathrm{cl}_D(B) \neq \varnothing, \qquad \mathcal{I}_D(A,B) = \mathrm{bd}_D(A) \cap \mathrm{bd}_D(B) \tag{30}$$

when the boundary intersection is the mediating field. This equation is still topological. Its physical use begins only after a support window $\chi_X^{(D)}$, a cell measure μ_D, and a nonnegative readout ν_D are declared. The exposure ratio $B_D(X)$ then supplies the natural support gate:

$$\mathcal{B}_X = B_D(X) = \frac{\nu_D(\mathrm{bd}_D\, X)}{\nu_D(\mathrm{cl}_D\, X)}. \tag{31}$$

Small $\mathcal{B}_X$ means most of the valued support is interior or closed. Large $\mathcal{B}_X$ means the support is boundary-rich and therefore more available for exchange, leakage, capture, or interaction.

3.2 From energy flux to local stress-energy contrast

A vacuum plus an energy flux becomes a local stress-energy contrast only after three choices are fixed: a reference vacuum, a support window, and a rule for how the incoming flux is retained, scattered, converted, or allowed to pass through. Let $|\Psi_F\rangle$ be a field state carrying the incoming flux. Relative to the reference state $|0\rangle$, the renormalised contrast inside the support window is

$$\Delta T^{\mu\nu}_{X,F}(x) = \chi_X^{(D)}(x)\left(\langle\Psi_F|\widehat{T}^{\mu\nu}(x)|\Psi_F\rangle - \langle 0|\widehat{T}^{\mu\nu}(x)|0\rangle_{\mathrm{ren}}\right). \tag{32}$$

This is the first standard-physics object in the chain. The support window does not create energy. It localises the comparison between the flux-bearing state and the chosen reference vacuum.

For an observer u^μ, the local energy-density contrast and stored support energy are

$$\Delta\varepsilon_{X,F}(x;u) = \Delta T^{\mu\nu}_{X,F} u_\mu u_\nu / c^2, \qquad E_X(t;u) = \int_{\Sigma_t} \Delta T^{\mu\nu}_{X,F} u_\mu n_\nu \,\mathrm{d}\Sigma. \tag{33}$$

The boundary of the support decides whether the flux merely crosses the region or becomes a local contrast with persistence. With s_ν the outward spatial normal to the support boundary on Σ_t, define the incoming energy flux by

$$\Phi_X^{\mathrm{in}}(t;u) = -\int_{\mathrm{bd}\, X_t} \Delta T^{\mu\nu}_{X,F} u_\mu s_\nu \,\mathrm{d}A, \tag{34}$$

where the sign convention makes inward energy flow positive. A local support energy changes through boundary flux and any declared exchange current:

$$\frac{\mathrm{d}E_X}{\mathrm{d}t} = \Phi_X^{\mathrm{in}} - \Phi_X^{\mathrm{out}} + \int_{X_t} Q^\nu u_\nu \,\mathrm{d}V. \tag{35}$$

Equation (35) is only local bookkeeping. Globally, it must sit inside the conserved ledger $\nabla_\mu(T^{\mu\nu} + T_R^{\mu\nu}) = 0$.

The flux has become a local stress-energy contrast, rather than a passing beam, when the support contains nonzero contrast and retains it over the interaction time:

$$N_X(t) = \int_{\Sigma_t} |\Delta\varepsilon_{X,F}(x;u)|\,\mathrm{d}\Sigma > 0, \qquad \inf_{s\in[t,t+\tau_f]} E_X(s;u) \geq E_{\min}. \tag{36}$$

If E_X rises and falls with no retention, the event is transient light-like transport through a region. If the flux is trapped, converted, bound, scattered into a standing configuration, or absorbed into a horizon support, then the support carries persistent stress-energy contrast. Only after this step can the later language of gravity, light-to-matter closure, or black-hole measure assimilation be invoked.

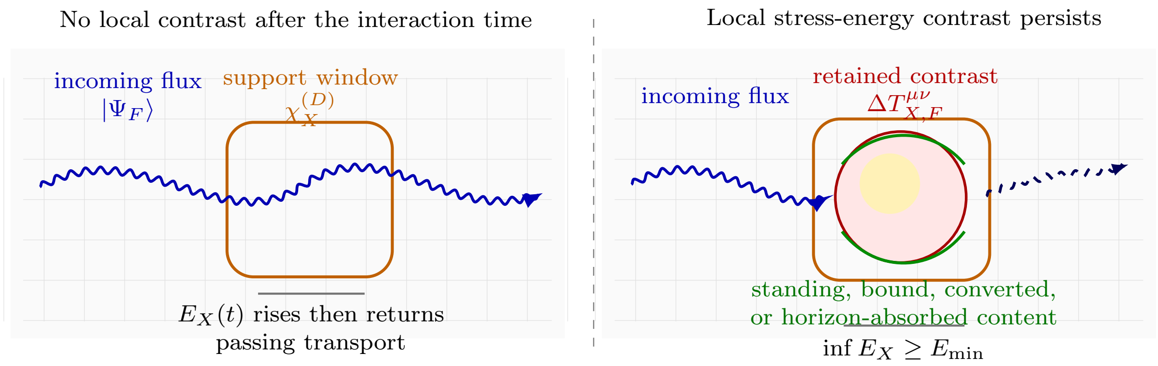

Figure 7: Flux-to-contrast picture. The left scene shows an energy flux crossing a support window without retained support energy. The right scene shows the case in which the same kind of flux is trapped, converted, bound, or absorbed so that the support carries persistent $\Delta T^{\mu\nu}_{X,F}$. This is the visual distinction between passing light-like transport and local stress-energy contrast.

3.3 Information transport: Vopson comparator and Austin recovery route

Information enters the reconstruction in two distinct ways. Melvin M. Vopson's mass-energy-information proposal supplies an external comparator: if a physical system stores $N_{\rm bit}$ bits under a specified thermodynamic rule, one may attach an information energy and its mass-equivalent value [6, 7, 8]. In the minimal Landauer normalisation this is written

$$E_I = N_{\rm bit} k_B T_L \ln 2, \qquad M_I = \frac{E_I}{c^2}. \tag{37}$$

This expression is not used here as an automatic rest-mass law. It is a measure-channel comparator. It says where an information-energy cost could be placed in μ_n when the temperature, memory substrate, logical operation, and thermodynamic context have all been specified. It does not make a bare abstract bit gravitate. Vopson's proposed second law of information dynamics can likewise be read as a possible tendency toward reduced represented informational entropy, but in the present reconstruction it becomes physically active only if a selector, carrier, and conservation law are declared.

Austin information transport supplies the internal route. It separates generated information from recovered information. Generated information can count the alternatives available to a support, but recovered information is what a physical carrier, observer, and decoder can actually read. With

$$V_{\rm rec} = (m_{\rm med}, r_{\rm res}, \nu_{\rm samp}, \kappa, \delta, \tau_{\rm ord}, D_{\rm dec})$$

standing for medium, resolution, sampling, coupling, tolerance, ordering time, and decoder data, the recovery bound is

$$I_{\rm rec}(t_{\rm obs} \mid V_{\rm rec}) \leq C_R(V_{\rm rec})\, t_{\rm obs}. \tag{38}$$

The bound is a transport statement, not a mass statement. Information reaches the support-bearing ledger through the energy and momentum of the carrier. For a carrier action $S_{\rm car}$, the standard gravitationally relevant object is

$$T^{\mu\nu}_{\rm car} = -\frac{2}{\sqrt{-g}}\frac{\delta S_{\rm car}}{\delta g_{\mu\nu}}. \tag{39}$$

If the carrier is electromagnetic, its stress-energy is the Maxwell stress-energy already used below. Modulation changes the recoverable structure of the signal, while the field's energy-momentum remains the route by which gravity, absorption, and mass-equivalent bookkeeping are affected.

A stronger information sector can be introduced only as a declared bridge. In that case a recovered-information density ι_R, conversion coefficient χ_I, and support X_I would be placed in an action

$$S_I[g, \iota_R, X_I, \chi_I, V_{\rm rec}] = \int \sqrt{-g}\, \mathcal{L}_I(g, \iota_R, X_I, \chi_I, V_{\rm rec})\, \mathrm{d}^4x, \qquad T_I^{\mu\nu} = -\frac{2}{\sqrt{-g}} \frac{\delta S_I}{\delta g_{\mu\nu}}. \tag{40}$$

No new gravitational claim follows until $\mathcal{L}_I$, the units of χ_I, the support condition on ι_R, and the conservation or exchange law for $T_I^{\mu\nu}$ are fixed independently. This is the same guardrail used for support-gated vacuum stress-energy.

The transport speed of information also has to be separated from bit-rate. For an energy-bearing carrier with total carrier energy $E_{\rm car}$ and spatial momentum $\mathbf{P}_{\rm car}$, a useful energy-transport velocity is

$$\mathbf{V}_{IE} = \frac{c^2 \mathbf{P}_{\rm car}}{E_{\rm car}}, \tag{41}$$

which gives the null limit for a coherent light-like carrier and a slower value in media or bound transport. The recoverable bit-rate is instead bounded by $C_R(V_{\rm rec})$. A photon packet may therefore transport information at the causal light limit while recovering only a finite number of bits per unit observer time.

The selector formalism is where Vopson and Austin meet the present support construction. A path may be energetically and topologically admissible while still failing as an information-transport path if no recoverable structure is carried. A refined information selector can be written as

$$\mathfrak{S}_{\mathfrak{C}_I}(\pi) = 1 \quad \Rightarrow \quad \mathfrak{S}_{\mathfrak{C}}(\pi) = 1, \qquad \kappa_{\rm rec}(\pi; V_{\rm rec}) > 0, \qquad I_{\rm rec}(\pi) \geq I_{\rm min}. \tag{42}$$

This is the missing formal element in the bridge: the selector decides which energy-supported paths are not only survivable, but also readable. The atom case follows this distinction. A forming atom stores recoverable information in quantum numbers, binding configuration, isotope content, spin state, and emission or absorption history. Its mass remains the standard mass of the nucleus, electrons, and binding energy. Information changes the mass budget only when it changes the physical state, the carrier energy, the thermodynamic storage cost, or an independently declared information-sector stress-energy.

3.4 Vacuum measure as a conserved effective source

Let $\rho_{\rm vac}^{\rm ren}$ denote the renormalised vacuum energy density in the chosen scheme. A homogeneous term of the form $-\rho_{\rm vac}^{\rm ren} g^{\mu\nu}$ is not a rendered local object. The bridge proposal is instead to assign a support-gated effective sector

$$T_{R,X}^{\mu\nu} = \mathfrak{F}_R^{\mu\nu}\left[\rho_{\rm vac}^{\rm ren}, \chi_X^{(D)}, \mathcal{B}_X, C_X, \varphi_X, g_{\mu\nu}\right], \tag{43}$$

where $\mathfrak{F}_R^{\mu\nu}$ is not arbitrary. It is a conditional modelling functional, not an identity. It must be fixed before comparison, it must have dimensions of stress-energy, and it must satisfy the conservation ledger

$$\nabla_\mu \left(T^{\mu\nu} + \sum_X T^{\mu\nu}_{R,X} \right) = 0. \tag{44}$$

No empirical prediction follows from Eq. (43) until $\mathfrak{F}^{\mu\nu}_R$ is independently specified. The minimal conserved-sector note writes this discipline as an ordinary sector plus a recursive or unresolved sector,

$$G_{\mu\nu} = \frac{8\pi G}{c^4} \left(T_{\mu\nu} + T^R_{\mu\nu} \right), \qquad \nabla_\mu (T^{\mu\nu} + T^{\mu\nu}_R) = 0 \tag{45}$$

[9]. If the sectors exchange measure, the same source uses

$$\nabla_\mu T^{\mu\nu} = Q^\nu, \qquad \nabla_\mu T^{\mu\nu}_R = -Q^\nu. \tag{46}$$

In a homogeneous reduction the exchange current is

$$Q^\nu = \Xi u^\nu, \qquad \Xi = \alpha_R C H \rho_R. \tag{47}$$

The local Surtea-supported analogue is the same idea with a boundary gate:

$$Q^\nu_X = \Xi_X u^\nu + q^\nu_{X,\perp}, \qquad \Xi_X = \alpha_X \, C_X \, \mathcal{H}_X \, \rho_{R,X} \, \mathcal{B}_X. \tag{48}$$

Here $q^\nu_{X,\perp} u_\nu = 0$ allows anisotropic boundary transfer, while α_X, C_X, $\mathcal{H}_X$, and $\rho_{R,X}$ must be supplied by the model. The proposed bridge from support to physical sourcing is therefore a conditional modelling rule. It becomes physically constraining only after the stress-energy embedding and exchange coefficients are fixed independently. If α_R, α_X, C_X, $\mathcal{H}_X$, or $\rho_{R,X}$ are adjusted after observing the target stress-energy or gravity, the bridge has become a fitted restatement rather than a prediction.

3.5 Gravity and null transport

Once $T^{\mu\nu}_{R,X}$ is present, gravity is not a new force in the framework. It is the ordinary response of the metric to the total stress-energy source. In the weak-field, slow-motion limit the local potential associated with the supported contrast obeys

$$\nabla^2 \Phi_X = \frac{4\pi G}{c^2} \, \Delta\varepsilon_X, \qquad \Delta\varepsilon_X = T^{\mu\nu}_{R,X} u_\mu u_\nu / c^2. \tag{49}$$

This is the precise limited sense in which a declared supported effective sector can be gravitationally active: the support-gated sector must first become a conserved stress-energy contrast.

Light then follows null transport in the resulting metric,

$$k^\mu k_\mu = 0, \qquad k^\nu \nabla_\nu k^\mu = 0. \tag{50}$$

In the survival-weighting bridge, light-like propagation is the frame-limited transport case

$$d\tau_R \to 0, \qquad S_\gamma \to 1 \quad \text{along the represented null path,} \qquad P^\mu_\gamma P_{\gamma\mu} = 0. \tag{51}$$

Energy is then read as propagation rather than rest mass:

$$E_\gamma = \hbar\omega = hf, \qquad M_{\text{eff},\gamma} = E_\gamma / c^2, \qquad M_{\text{rend},\gamma} = 0. \tag{52}$$

For a null energy flux, the black-hole recovery note uses

$$T_\gamma^{\mu\nu} = \Phi_\gamma k^\mu k^\nu, \qquad k^\mu k_\mu = 0, \tag{53}$$

which keeps the photon locally light-like while allowing it to carry stress-energy [10]. Observer-centred readout can encode redshift by

$$n_z(r) = 1 + z(r), \qquad \nu_{\text{obs}} = \frac{\nu_{\text{em}}}{n_z(r)}, \qquad E_{\text{obs}} = \frac{E_{\text{em}}}{n_z(r)} \tag{54}$$

[11, 12]. The corresponding frequency-mass-equivalent measure is

$$M_{R,\text{obs}} = \frac{h\nu_{\text{obs}}}{c^2} = \frac{h\nu_{\text{em}}}{c^2 n_z(r)}. \tag{55}$$

This does not alter the local measured speed of light. It records the frequency-energy readout of light transported through the metric generated by the total stress-energy source.

3.6 Matter closure and black-hole assimilation

The Einstein-Planck note places the frequency-mass-equivalent channel in the measure package:

$$\mu_n \supset (E_n, f_n, M_{R,n}), \qquad M_{R,n} = \frac{E_n}{c^2} = \frac{hf_n}{c^2}. \tag{56}$$

Matter-like transport still requires more than frequency. The condition is the whole support chain

$$\text{matter-like transport} \Longrightarrow \text{closure+support+recurrence+interaction+survival weighting.}$$

Pair production, Higgs mass terms, and QCD confinement are therefore standard sector closures placed downstream of the supported vacuum bridge. The bridge represents vacuum measure as gravitationally and optically active only when it produces stress-energy. Matter-like representation appears only after a conservation-respecting closure channel produces support-bearing massive excitations.

For black holes, the same support construction reaches a limiting case when the selected support is closed against exterior recovery. In a relativistic embedding this must be expressed by an ordinary horizon or trapped-surface condition, for example

$$\theta_+(X_E) \le 0 \quad \text{or operationally} \quad \eta_{\text{esc}}(X_E \to V_{\text{ext}}) \to 0, \tag{57}$$

where θ_+ is the outgoing null expansion when such a geometry is available and η_{esc} is a declared exterior escape fraction. This is the sense in which a black-hole support can arise from the same support machinery. It is not a replacement for the standard horizon condition.

For black holes, the same bookkeeping becomes measure assimilation. The recovery note writes the carrier update as a pair of bookkeeping maps, not as new dynamics. Here $\mathcal{P}_{\text{proc}}$ is a processing map that splits the incoming measure package into exteriorly recoverable and absorbed parts, while $\mathcal{P}_{\text{cons}}$ projects the absorbed part onto the conserved quantities that update the black-hole measure package:

$$\sigma_{\text{in}} = (X_{\text{in}}, \varphi_{\text{in}}, \mu_{\text{in}}, S_{\text{in}}), \qquad \mathcal{P}_{\text{proc}}(\mu_{\text{in}}) = \mu_{\text{out}} + \mu_{\text{abs}}, \tag{58}$$

followed by exterior recovery failure and conserved measure assignment,

$$I_{\rm rec}(\sigma_{\rm in} \mid V_{\rm ext}) \to 0, \qquad \mu_{{\rm BH},n+1} = \mu_{{\rm BH},n} + \mathcal{P}_{\rm cons}(\mu_{\rm abs}). \tag{59}$$

For a photon packet this gives

$$\Delta M_{\rm BH} = \eta_{\rm abs} E_{\gamma,\infty}/c^2, \qquad \Delta J_{\rm BH} = \eta_{\rm abs} L_{z,\gamma}, \qquad \Delta Q_{\rm BH} = 0. \tag{60}$$

The exterior description does not preserve the recoverable carrier history, but it does preserve the conserved measure assigned to the black-hole support package.

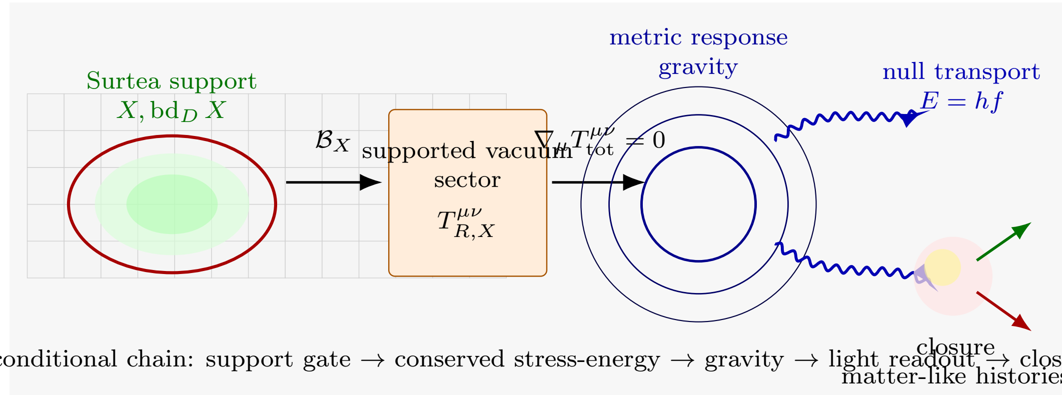

Figure 8: Conditional supported-vacuum bridge. Surtea support supplies a boundary gate. A declared conserved stress-energy embedding lets the support gravitate. The resulting metric shapes null transport, while matter-like histories require an additional closure channel.

4 Standard QFT Mass Bookkeeping

4.1 Stress-energy and invariant mass

Standard identity. Let $(\mathcal{M}, g)$ be a spacetime with a Cauchy slice Σ_t. For a field configuration or quantum state C, write the renormalised stress-energy expectation relative to the chosen reference vacuum as

$$\Delta T^{\mu\nu}_C(x) = \langle C|\widehat{T}^{\mu\nu}(x)|C\rangle_{\rm ren} - \langle 0|\widehat{T}^{\mu\nu}(x)|0\rangle_{\rm ren}. \tag{61}$$

The subtraction convention is part of the physical model; the point here is only that local mass bookkeeping uses stress-energy contrast rather than an unqualified infinite zero-point density.

When a configuration is sufficiently localised and isolated, its total four-momentum is

$$P^\mu_C = \frac{1}{c}\int_{\Sigma_t} \Delta T^{\mu\nu}_C \, \mathrm{d}\Sigma_\nu. \tag{62}$$

In flat spacetime with Σ_t an equal-time slice this reduces to

$$P^0_C = \frac{E_C}{c}, \qquad P^i_C = \frac{1}{c}\int_{\Sigma_t} \Delta T^{0i}_C \, \mathrm{d}^3x. \tag{63}$$

The invariant rest mass of the localised configuration is then

$$M_C^2 c^2 = P_C^\mu P_{C\mu}, \qquad \text{or equivalently} \qquad M_C^2 c^4 = E_C^2 - c^2 |\mathbf{P}_C|^2. \tag{64}$$

In the rest frame of a massive localised configuration,

$$\mathbf{P}_C = 0, \qquad M_C = \frac{E_C}{c^2}. \tag{65}$$

This identity is the broadest mass formula used in the present note. Any sector-specific mass expression must reduce to it when the total localised stress-energy of the configuration is evaluated.

4.2 Mass shell and persistence

Standard identity. A stable one-particle excitation of mass m has a mass-shell condition

$$p^\mu p_\mu = m^2 c^2. \tag{66}$$

In interacting QFT the same information appears in the pole structure of the two-point function. A stable scalar excitation, for example, contributes a pole schematically of the form

$$G(p^2) \sim \frac{Z}{p^2 - m^2 c^2 + i\epsilon}. \tag{67}$$

A resonance with decay width Γ_C is represented by a displaced pole, schematically

$$p^0 \sim E_C - \frac{i}{2}\hbar\Gamma_C, \qquad \tau_C \sim \Gamma_C^{-1}. \tag{68}$$

Mass-shell bookkeeping already contains a persistence distinction: stable particles have infinite ideal lifetime, while resonances have finite lifetime. Rendering will not replace this bookkeeping. It will add an explicit support-and-duration criterion that also covers partial cases.

4.3 Local energy contrast

Let u^μ be the four-velocity of a local observer. The observer-measured renormalised energy-density contrast is

$$\Delta\varepsilon_C(x; u) = \frac{1}{c^2} \Delta T_C^{\mu\nu}(x) u_\mu u_\nu. \tag{69}$$

A uniform Lorentz-invariant vacuum contribution proportional to $-g^{\mu\nu}$ has no localised contrast by itself. A particle, hadron, bound nucleus, localised wave packet, Casimir boundary perturbation, or horizon-separated excitation may have contrast relative to the chosen background. Rendering begins by formalising that distinction.

5 Formal Rendering Criterion

5.1 Localisation

Definition. Fix an observer u^μ, a time slice Σ_t, a background state $|0\rangle$, and a tolerance $0 < \epsilon_L < 1$. For a spatial ball $B_R(x_0) \subset \Sigma_t$, define the absolute contrast content

$$N_C(t) = \int_{\Sigma_t} |\Delta\varepsilon_C(x; u)| \, \mathrm{d}^3 x \tag{70}$$

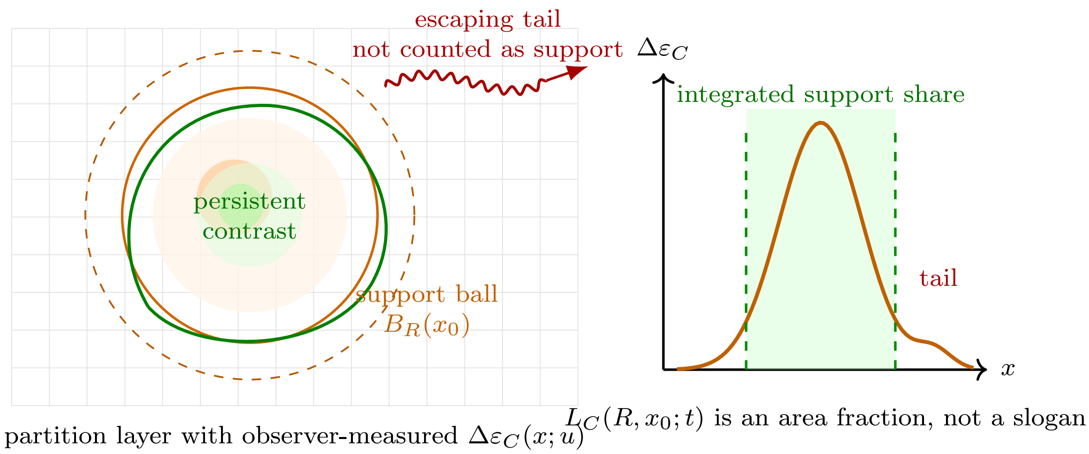

Figure 9: Rendered contrast as a picture. The support is a finite region on a partition layer carrying stress-energy contrast. The localisation fraction counts the share inside $B_R(x_0)$, while tails and leakage remain visible instead of being hidden by the word "particle".

and the localisation fraction

$$L_C(R, x_0; t) = \frac{\int_{B_R(x_0)} |\Delta\varepsilon_C(x; u)| \, \mathrm{d}^3x}{N_C(t)} \qquad (N_C(t) > 0). \tag{71}$$

The configuration is (R, ϵ_L)-localised at time t when there is some centre x_0 such that

$$L_C(R, x_0; t) \geq 1 - \epsilon_L. \tag{72}$$

This is deliberately operational. It does not say that the field literally vanishes outside B_R. It says that the relevant contrast is sufficiently concentrated inside a characteristic support scale.

5.2 Persistence

Definition. Let $\tau_\int$ be the characteristic time required for an interaction, detection, or causal registration in the intended context. For a localised configuration define the persistence score

$$\mathsf{Pers}_C(R, x_0; t, \tau_\int) = \inf_{s \in [t, t+\tau_\int]} L_C(R, x_0; s). \tag{73}$$

The configuration is $(R, \epsilon_L, \epsilon_P, \tau_\int)$-persistent when

$$\mathsf{Pers}_C(R, x_0; t, \tau_\int) \geq 1 - \epsilon_P. \tag{74}$$

For a resonance or unstable excitation with width Γ_C, a useful model-level persistence factor is

$$\Pi_C(\tau_\int) = \exp(-\Gamma_C \tau_\int). \tag{75}$$

This is a standard survival factor for an unstable state. It turns the qualitative phrase "sufficient duration" into a measurable comparison with the time scale on which the configuration must register.

5.3 Binary rendering

Definition. A configuration C is rendered relative to the experimental or theoretical context

$$\mathfrak{C} = (u^\mu, \Sigma_t, |0\rangle, R, \epsilon_L, \epsilon_P, \tau_\int, E_{\min}) \tag{76}$$

when all of the following hold:

$$N_C(t) > 0, \tag{77}$$
$$\exists x_0 : \quad L_C(R, x_0; t) \geq 1 - \epsilon_L, \tag{78}$$
$$\exists x_0 : \quad \mathsf{Pers}_C(R, x_0; t, \tau_\int) \geq 1 - \epsilon_P, \tag{79}$$
$$E_C(R, x_0; t) = \int_{B_R(x_0)} \Delta\varepsilon_C(x; u)\, \mathrm{d}^3x \geq E_{\min}. \tag{80}$$

The thresholds are not universal constants. They specify the context in which a configuration is claimed to have coordinate, duration, and detectable energetic contrast.

> **Rendering criterion.** A configuration is rendered when it carries localised stress-energy contrast over a characteristic support and preserves that contrast over the time needed for interaction or detection. Rendering is therefore a support-plus-persistence classification of standard field configurations.

5.4 Threshold non-triviality

The criterion is empty if the thresholds are allowed to drift. If $R \to \infty$, every finite-energy configuration becomes localised. If $\tau_\int \to 0$, persistence becomes automatic. If $E_{\min} \to 0$, any arbitrarily small contrast can be counted. For this reason the context $\mathfrak{C}$ must be declared before classification, and the same context must be used for rendered and unrendered cases.

5.5 Worked Gaussian packet example

Fix the context before evaluating the packet:

$$R = 2\sigma, \qquad \epsilon_L = 0.30, \qquad \epsilon_P = 0.20, \qquad E_{\min} > 0, \qquad \tau_\int \text{ given.} \tag{81}$$

At $t = t_0$, take an energy-density contrast

$$\Delta\varepsilon_G(\mathbf{x}; t_0) = \frac{E_0}{(2\pi\sigma^2)^{3/2}} \exp\left[-\frac{|\mathbf{x} - \mathbf{x}_0|^2}{2\sigma^2}\right], \qquad E_0 \geq E_{\min}. \tag{82}$$

The total contrast content is $N_G(t_0) = E_0$. The localisation fraction inside a ball of radius R centred at $\mathbf{x}_0$ is

$$L_G(R) = \operatorname{erf}\left(\frac{R}{\sqrt{2}\sigma}\right) - \sqrt{\frac{2}{\pi}}\,\frac{R}{\sigma} \exp\left[-\frac{R^2}{2\sigma^2}\right]. \tag{83}$$

For the predeclared support scale $R = 2\sigma$,

$$L_G(2\sigma) = \operatorname{erf}(\sqrt{2}) - 2\sqrt{\frac{2}{\pi}}\,\mathrm{e}^{-2} \approx 0.739 > 1 - \epsilon_L = 0.70. \tag{84}$$

A resonance-like decay model with width Γ_G gives the persistence factor

$$\Pi_G(\tau_\int) = \exp(-\Gamma_G \tau_\int). \tag{85}$$

Under the fixed persistence threshold $\epsilon_P = 0.20$, the packet is rendered over the chosen interaction time when

$$\Gamma_G \tau_\int \leq -\ln(0.80) \approx 0.223, \tag{86}$$

and it fails the same context when this inequality fails. If the radius had instead been predeclared as $R = \sigma$, then $L_G(\sigma) \approx 0.199$, so the packet would fail localisation even with the same total energy. The classification is therefore support- and context-sensitive, not merely an energy label.

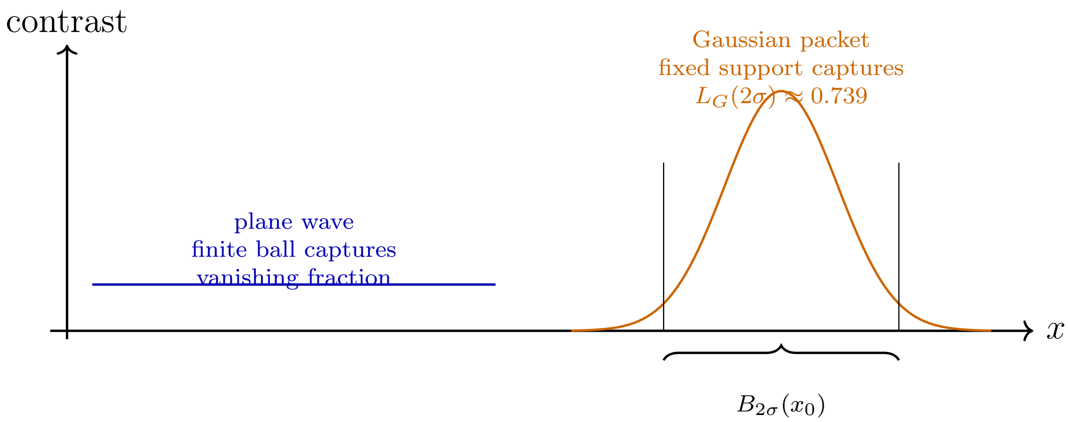

Figure 10: Localisation fraction example. A plane wave can be on shell but fail finite-support rendering, while a Gaussian packet can satisfy the same support criterion once thresholds are fixed.

5.6 Relation to the on-shell condition

The rendering criterion is close to the on-shell condition, but it is not the same predicate. The distinction matters because otherwise "rendering" would only rename a familiar QFT bookkeeping rule.

Standard on-shell predicate. For a one-particle external excitation, write

$$\mathcal{O}(C) = 1 \iff p^\mu p_\mu = m^2 c^2 \quad \text{or, equivalently, the propagator has a real stable pole.} \tag{87}$$

This is a spectral-support, momentum-space, or pole-structure statement. It fixes the relevant mass-shell or pole condition in the spectral representation. It does not by itself require finite spatial support, an interaction-time threshold, or a chosen registration channel.

Rendering predicate. By contrast,

$$\mathcal{R}_\mathfrak{C}(C) = 1 \iff C \text{ satisfies Eqs. (77)–(80) in context } \mathfrak{C}. \tag{88}$$

This is a support-duration-registration statement. It depends on localised stress-energy contrast and on the time scale over which the configuration can participate in an interaction.

Proposition. $\mathcal{R}_\mathfrak{C}$ is not equivalent to $\mathcal{O}$.

Proof by counterexamples. First, an ideal momentum eigenstate $|p\rangle$ may be exactly on shell:

$$p^\mu p_\mu = m^2 c^2. \tag{89}$$

But it is delocalised. In a box-normalised limit with volume V_{box}, its energy-density contrast is spread across the box, so for any fixed finite support ball $B_R(x_0)$,

$$L_C(R, x_0; t) \sim \frac{\text{Vol}(B_R)}{V_{\text{box}}} \longrightarrow 0 \qquad (V_{\text{box}} \to \infty). \tag{90}$$

Thus $\mathcal{O}(C) = 1$ while $\mathcal{R}_\mathfrak{C}(C) = 0$ for any context requiring localised support. On-shellness alone is therefore insufficient for rendering.

Second, a resonance or unstable localised excitation can be rendered over a short interaction time while failing the exact real-pole on-shell condition. Its pole is displaced,

$$p^0 \sim E_C - \frac{i}{2}\hbar\Gamma_C, \tag{91}$$

so it is not on the exact stable real mass shell. Nevertheless, if its support is localised and

$$\exp(-\Gamma_C \tau_\int) \geq 1 - \epsilon_P, \tag{92}$$

then it satisfies the rendering persistence condition over the relevant interaction. Thus rendering can hold, or hold to high degree, where exact stable on-shellness fails.

Third, a macroscopic bound system, detector click, Casimir boundary perturbation, or localised wave packet may be a rendered configuration without being a single elementary on-shell particle. Its mass or energy-equivalent measure is computed from total stress-energy,

$$M^2 c^4 = E^2 - c^2 |\mathbf{P}|^2, \tag{93}$$

but its renderedness comes from support and persistence of an organised configuration, not from being an elementary external line.

□

The conclusion is precise: on-shellness is a spectral or asymptotic-state condition, while rendering is an operational support-persistence condition. They overlap for stable detected particles, but neither reduces to the other.

6 Rendering Functional and Graded Persistence

6.1 A graded rendering score

Definition. For partial cases define a rendering score

$$\mathcal{R}_C(t) = \sup_{R, x_0} \left[L_C(R, x_0; t)\, \mathsf{Pers}_C(R, x_0; t, \tau_\int)\, Q_C(t)\, D_C(t) \right], \qquad 0 \leq \mathcal{R}_C(t) \leq 1. \tag{94}$$

Here $Q_C(t) \in [0, 1]$ records sector closure: conservation conditions, allowed quantum numbers, colour-singlet status, or the interaction closure needed by the sector. The factor $D_C(t) \in [0, 1]$ records detector, channel, or exterior accessibility. One may have $Q_C \simeq 1$ for a stable colour-singlet particle and $D_C \simeq 1$ in the detector basis; a coloured quark-like excitation has no isolated colour-singlet external channel; a horizon-separated mode may

Table 6: Rendered and unrendered cases compared with on-shell status.

Case	On-shell status	Rendering status
Ideal plane wave	On shell if $p^2 = m^2c^2$.	Not rendered in finite-support contexts because it is delocalised.
Localised stable particle wave packet	On shell to the accuracy allowed by packet spread.	Rendered when support and interaction-time thresholds are met.
Broad resonance	Not an exact stable real-pole state.	Partially rendered, or rendered over short $\tau_\int$, according to $\exp(-\Gamma_C \tau_\int)$.
Virtual internal line	Off shell or integrated over momenta inside an amplitude.	Not rendered as an external object unless a real registered channel is produced.
Photon wave packet	Null on shell, $P^2 = 0$.	Rendered as light-like energy transport, but not rest-massive.
Macroscopic bound system	Not a single elementary on-shell excitation.	Rendered if localised and persistent; invariant mass follows from total stress-energy.

have nonzero interior structure while $D_C \to 0$ for exterior recovery; a virtual internal line has no external registration channel unless a real registered product is produced.

The factors Q_C and D_C are not new forces. They are bookkeeping slots for the sectoral fact that localisation alone is insufficient.

6.2 Rendering as prevented reversal

The phrase "prevented from reversing" can be written without teleology. Let $\mathcal{A}_{C\to 0}(\tau)$ denote the amplitude, probability, or effective channel weight for the localised configuration C to return to the unrendered reference sector during a time τ. The precise object depends on the sector. For an unstable particle it is controlled by a decay width; for pair production it is controlled by separation and available annihilation channels; for QCD it is controlled by confinement and colour-singlet constraints.

Definition. The reversal suppression over an interaction time is

$$I_C(\tau_\int) = 1 - \mathcal{P}_{C\to 0}(\tau_\int), \qquad 0 \le I_C \le 1, \tag{95}$$

where $\mathcal{P}_{C\to 0}$ is the probability or effective channel weight for return to the reference sector. A more explicit rendering score may then use

$$\mathcal{R}^*_C(t) = \sup_{R,x_0} L_C(R, x_0; t)\, \mathsf{Pers}_C(R, x_0; t, \tau_\int)\, I_C(\tau_\int)\, Q_C(t)\, D_C(t). \tag{96}$$

This equation is a definition, not an additional dynamical law. Its purpose is to make the rendering vocabulary calculable once the sector dynamics are known.

6.3 Rendered mass measure

Consequence of standard identities. If C is rendered and has total four-momentum P^μ_C, then its rest-mass measure is

$$M_{\rm rend}(C) = \frac{1}{c}\sqrt{P^\mu_C P_{C\mu}}, \tag{97}$$

when $P^{\mu}_{C} P_{C\mu} > 0$. Its energy-equivalent mass measure is

$$M_{\text{eff}}(C; u) = \frac{E_C(u)}{c^2} = \frac{1}{c^2} \int_{\Sigma_t} \Delta T^{\mu\nu}_{C} u_\mu n_\nu \, \mathrm{d}\Sigma, \tag{98}$$

where n^ν is the slice normal. A massive object has both a rest mass and an energy-equivalent measure. A photon has $M_{\text{rend}} = 0$ but $M_{\text{eff}} = E/c^2$.

7 Sector Bookkeeping and Reconstructions

7.1 Higgs/Yukawa rest-mass sector

Standard identity. In the Standard Model, a Dirac fermion mass arises from a Yukawa coupling to the Higgs doublet. Schematically,

$$\mathcal{L}_Y = -y_f \, \overline{\psi}_L \Phi \psi_R + \text{h.c.} \tag{99}$$

After electroweak symmetry breaking,

$$\Phi = \frac{1}{\sqrt{2}} \begin{pmatrix} 0 \\ v + h_H \end{pmatrix}, \tag{100}$$

so that

$$\mathcal{L}_Y = -m_f \overline{\psi} \psi - \frac{m_f}{v} h_H \overline{\psi} \psi, \qquad m_f = \frac{y_f v}{\sqrt{2}}. \tag{101}$$

For the weak gauge bosons,

$$m_W = \frac{g v}{2}, \qquad m_Z = \frac{\sqrt{g^2 + g'^2}\, v}{2}, \qquad m_\gamma = 0. \tag{102}$$

The electroweak symmetry-breaking account and the observed Higgs boson are standard imports in this reconstruction [13, 14, 15, 16, 17].

Rendering interpretation. The Higgs sector supplies rest-mass terms for field excitations that are rendered as localised persistent external configurations. Rendering does not determine the Yukawa constants y_f. It states the structural condition under which the mass term is borne by a configuration with support and duration.

For a rendered fermion wave packet C_f, the sector contribution to the rest-energy budget is

$$E^{(H)}_{C_f} = m_f c^2 = \frac{y_f v}{\sqrt{2}} c^2, \tag{103}$$

before kinetic, binding, or environmental contributions are added. The formula is standard. The rendering statement is that $E^{(H)}_{C_f}$ belongs to a localised persistent excitation, not to a free-floating unrendered substrate mode.

7.2 QCD confinement sector

Standard identity. A hadron H has mass because the localised colour-singlet state carries total QCD stress-energy. In its rest frame,

$$M_H c^2 = \langle H | \int \mathrm{d}^3 x \, \widehat{T}^{00}_{\text{QCD}}(x) | H \rangle, \tag{104}$$

with the state normalised as a localised wave packet. The confinement and hadron-mass interpretation used here is the ordinary QCD one, not a rendering prediction of the hadron spectrum [18, 19, 20, 21]. A schematic sector budget is

$$M_H c^2 = E_{\text{quark rest}} + E_{\text{quark kin}} + E_{\text{gluon}} + E_{\text{interaction/anomaly}}. \tag{105}$$

The precise gauge-invariant decomposition is convention-dependent, but the total M_H is not. The trace relation

$$T^{\mu}_{\ \mu} = \sum_q m_q(1+\gamma_m)\bar{q}q + \frac{\beta(g)}{2g} G^a_{\mu\nu} G^{a\mu\nu} \tag{106}$$

records the standard fact that QCD scale generation and the trace anomaly are central to hadronic mass. In the chiral limit $m_q \to 0$, hadrons remain massive because confinement and QCD dynamics still provide localised stress-energy.

Rendering interpretation. QCD confinement is the limit case of self-locking rendering. A colour excitation cannot be isolated as a free rendered quark. Attempts to separate colour charge increase the gluon-field energy until new colour-singlet hadronic configurations are produced. The rendered object is therefore not a bare quark but a localised colour-singlet configuration whose mass budget is the total confined QCD stress-energy.

This rewrites the standard QCD mass budget in rendering notation:

$$M^{\text{QCD}}_{\text{rend}}(H) = \frac{1}{c^2} \langle H | \int \mathrm{d}^3x\, \widehat{T}^{00}_{\text{QCD}}(x) | H \rangle_{\text{rest}}, \tag{107}$$

with confinement supplying the support and long-lived hadronic identity. This formula records the standard fact that the mass of ordinary matter is dominated by QCD binding and field energy without treating the proton as a static container of three pre-existing massive objects.

7.3 Bound-system and relativistic energy sector

Standard identity. Any localised isolated system has invariant mass given by the total stress-energy, not by a simple sum of constituent rest masses. For a bound configuration B in its rest frame,

$$M_B c^2 = \sum_a m_a c^2 + K_{\text{constituents}} + U_{\text{fields}} + E_{\text{binding}} + E_{\text{thermal}} + \cdots. \tag{108}$$

The binding term may be negative relative to separated constituents; thermal or excitation energy may be positive. A stressed spring, hot gas, bound nucleus, or excited atom contributes to inertial and gravitational mass through the total localised energy.

Rendering interpretation. Bound-system mass is rendered mass when the total energy is carried by a persistent localised configuration. What becomes matter-facing is the whole organised field-and-particle state:

$$M^{\text{bound}}_{\text{rend}}(B) = \frac{1}{c^2} \int_{\text{supp}(B)} \Delta T^{00}_B \, \mathrm{d}^3x \quad \text{in the rest frame.} \tag{109}$$

This is not a new mass law. It is the standard invariant-mass identity read through the rendering criterion.

7.4 Light-like rendered transport and matter closure

Standard identity. Classical electromagnetic propagation already contains storage and transport. In vacuum the electromagnetic energy density and Poynting vector are

$$u_{\mathrm{EM}} = \frac{1}{2}\left(\epsilon_0|\mathbf{E}|^2 + \frac{|\mathbf{B}|^2}{\mu_0}\right), \qquad \mathbf{S} = \frac{1}{\mu_0}\mathbf{E}\times\mathbf{B}. \tag{110}$$

Quantisation gives the photon energy channel

$$E_\gamma = \hbar\omega = hf. \tag{111}$$

For an ideal photon or null electromagnetic wave packet,

$$P^\mu P_\mu = 0, \qquad E_\gamma = \hbar\omega, \qquad |\mathbf{P}| = \frac{E_\gamma}{c}. \tag{112}$$

The rest mass is therefore

$$M^{\mathrm{rest}}_{\mathrm{rend}}(\gamma) = 0, \tag{113}$$

while the energy-equivalent measure is

$$M_{\mathrm{eff}}(\gamma) = \frac{E_\gamma}{c^2} = \frac{\hbar\omega}{c^2}. \tag{114}$$

Rendering interpretation. Light can be rendered without being massive. A photon wave packet has coordinate, duration, energy, and momentum in the operational sense relevant to detection. It does not have a rest frame or nonzero invariant rest mass. Thus rendering is not identical to mass generation. Rendering supplies the support/persistence condition; sectoral coupling determines whether the rendered configuration has rest mass, energy-equivalent mass only, or both.

Light becomes matter-like only when conservation and interaction closure allow photon-carried energy to be re-expressed as massive field excitations. A lone photon in empty space cannot become an electron-positron pair by itself because energy and momentum cannot both close. By contrast, the channels

$$\gamma + \gamma \to e^- + e^+, \qquad \gamma + Z \to e^- + e^+ + Z \tag{115}$$

can close when the energy threshold and recoil or counter-propagating momentum conditions are satisfied. The threshold rest-energy condition is

$$E_{\mathrm{available}} \geq 2m_e c^2, \tag{116}$$

with additional energy required in realistic kinematics. Strong external fields supply another standard closure route. In Schwinger's constant-field result, the critical electric-field scale is

$$E_{\mathrm{Sch}} = \frac{m_e^2 c^3}{e\hbar} \approx 1.3 \times 10^{18}\,\mathrm{V\,m^{-1}}, \tag{117}$$

and the pair-production rate is exponentially suppressed when $E \ll E_{\mathrm{Sch}}$ [22]. In rendering terms, the field or scattering environment supplies the boundary condition that prevents immediate reversal. Frequency-energy is therefore necessary bookkeeping, not sufficient matter closure [23, 12].

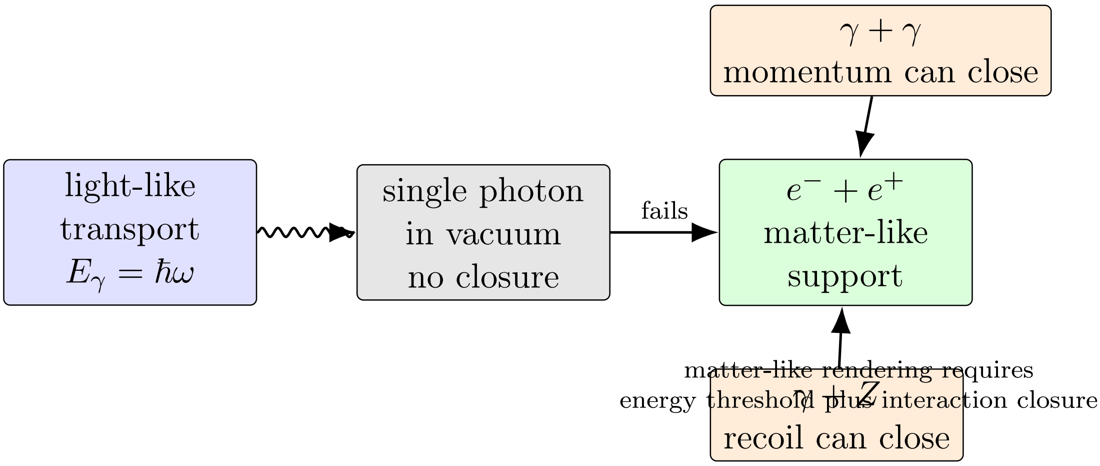

Figure 11: Light-to-matter closure. Photon energy can become massive particle-pair support only when conservation laws and an interaction channel close.

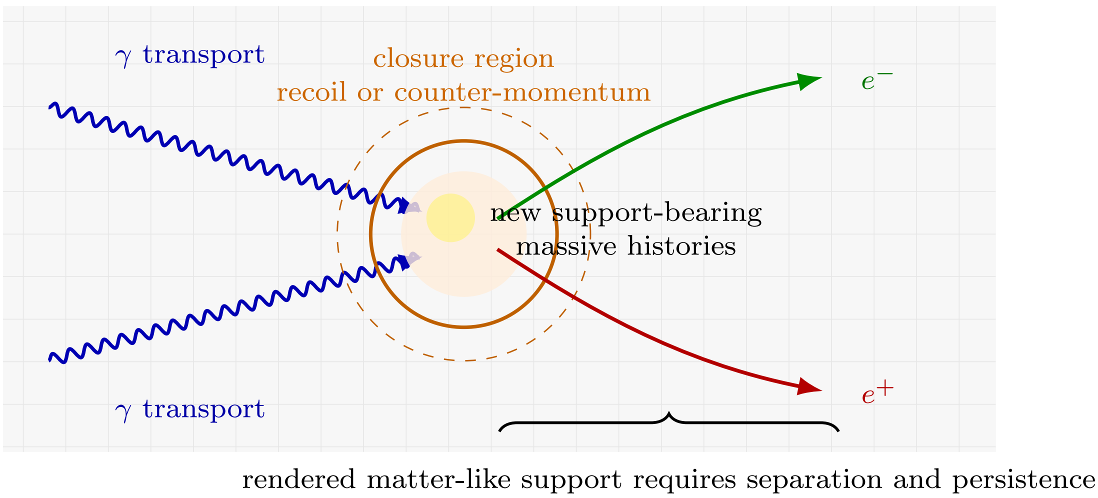

Figure 12: Pair-production scene. Photon-carried energy becomes matter-like only when a closure environment supplies conservation bookkeeping and the resulting charged histories persist as support-bearing excitations.

Table 7: Compact sector reconstruction of rendered mass and energy transport.

Sector	**Standard mass expression**	**Rendering role**	**Guardrail**
Higgs/Yukawa	$m_f = y_f v/\sqrt{2}$	Rest-mass term borne by localised persistent field excitation.	Does not predict y_f.
QCD confinement	$M_H c^2 = \langle \int T^{00}_{\text{QCD}} \rangle$	Self-locking localised colour-singlet stress-energy.	Does not isolate free quark mass as hadron mass.
Bound systems	$M^2c^4 = E^2 - c^2\lvert\mathbf{P}\rvert^2$	Total localised energy contributes to system mass.	Not additive over rest masses alone.
Light-like transport	$P^2 = 0,\ E = \hbar\omega$	Rendered energy transport with detection support.	Energy-equivalent mass is not photon rest mass.

7.5 Compact sector table

8 Black-Hole Measure Assimilation

Black-hole absorption is the sharpest guardrail for the claim that light can add mass without having rest mass. Let an exterior photon packet carry energy $E_{\gamma,\infty}$ as measured at infinity [10]. If a declared absorbed fraction η_{abs} crosses the horizon recovery boundary, then the exterior black-hole mass bookkeeping updates by

$$\Delta M_{\text{BH}} = \frac{\eta_{\text{abs}} E_{\gamma,\infty}}{c^2}. \tag{118}$$

This is not photon rest mass. It is the energy-equivalent contribution of absorbed null stress-energy to the exterior black-hole mass parameter. If the incoming carrier also has angular momentum or charge, those conserved quantities enter the black-hole measure package through the corresponding updates

$$\mu_{\text{BH}} = (M_{\text{BH}}, J_{\text{BH}}, Q_{\text{BH}}, A_H, \ldots), \qquad \mu_{\text{BH}} \mapsto \mu_{\text{BH}} + \Delta\mu_{\text{abs}}. \tag{119}$$

The carrier history is no longer exteriorly recoverable after it crosses the horizon, but its conserved measure has not vanished. In the support representation, the black hole is represented as

$$\sigma_{\text{BH}} = (X_{\text{BH}}, \varphi_{\text{BH}}, \mu_{\text{BH}}, S_{\text{BH}}), \tag{120}$$

where X_{BH} is the compact exterior support, φ_{BH} stores horizon, rotation, frame-dragging, and propagation data, μ_{BH} stores exterior conserved measures, and S_{BH} stores represented persistence of the black-hole object. The horizon is a recovery boundary, not a statement that energy stops being counted.

8.1 Observer and horizon dependence

Quantum field theory in curved spacetime gives a standard reason to keep rendering observer-indexed. Hawking radiation assigns thermal outgoing particle content to a black-hole background, while the Unruh effect assigns a thermal bath to uniformly accelerated

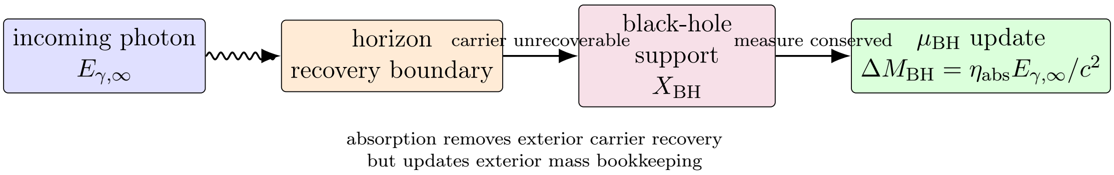

Figure 13: Black-hole measure assimilation. Absorbed light updates the exterior black-hole mass through conserved energy bookkeeping without assigning rest mass to the photon.

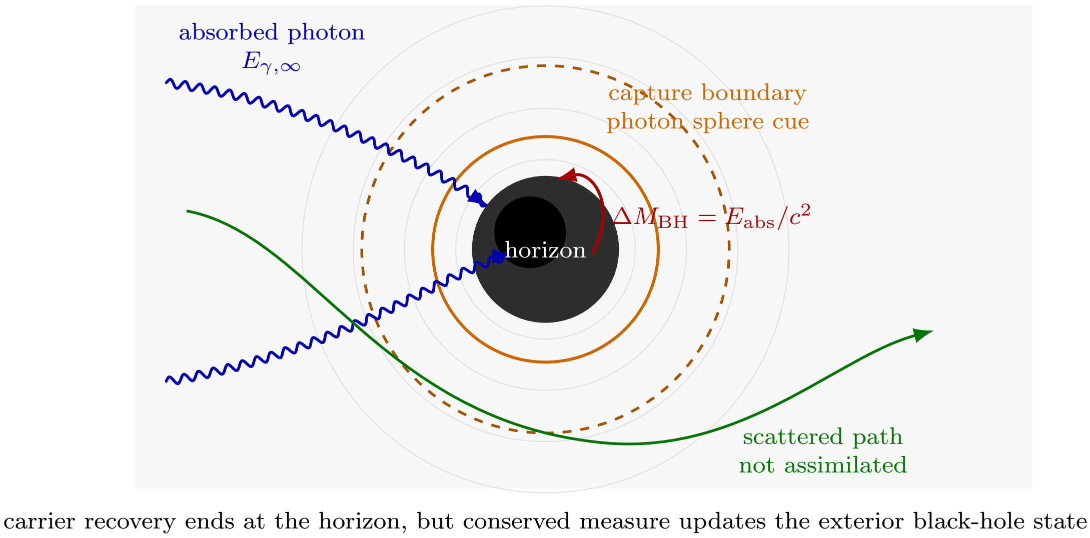

Figure 14: Black-hole capture scene. Incoming null energy either scatters or crosses the recovery boundary. The absorbed carrier is no longer exteriorly recoverable, while its energy contributes to the exterior mass parameter.

detectors in a state inertial detectors describe differently [24, 25]. Particle content is therefore tied to slicing, detector coupling, and causal structure. This does not make the physics subjective. It says that a rendered particle channel is defined through the operational frame in which support, valuation, and persistence are registered.

9 Survival-Weighting Bridge: Support, Recurrence, Survival, and μ_n

9.1 Structured recursive state

Austin recursive survival weighting writes a structured recursive state as

$$\sigma_n = (X_n, \varphi_n, \mu_n, S_n), \tag{121}$$

where X_n carries support/topological objecthood data, φ_n carries phase or transport data, μ_n carries physical measure data, and S_n carries survival weight.

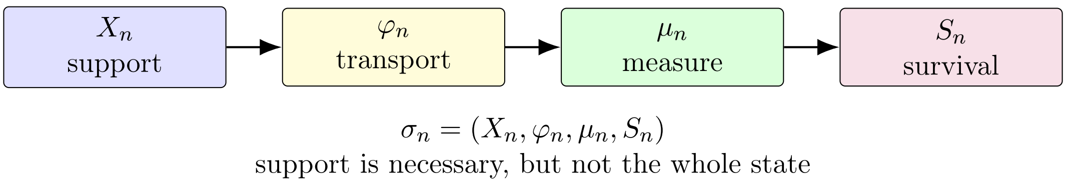

Figure 15: Structured recursive state tuple. Support, transport, measure, and survival slots must remain separated so that support is not mistaken for energy, and survival is not mistaken for mass generation.

Bridge postulate R1: support correspondence. A rendered QFT configuration C maps to a recursive support component X_n when its localisation fraction satisfies Eq. (72). The support X_n is the recursive representation of the characteristic region over which stress-energy contrast is concentrated.

Bridge postulate R2: measure placement. The physical measure package μ_n may contain

$$\mu_n \supset (\mathcal{E}_n, f_n, M_{\mathrm{rend},n}, M_{\mathrm{eff},n}, P^{\mu}_{n}, Q_n), \tag{122}$$

where

$$M_{\mathrm{eff},n} = \frac{\mathcal{E}_n}{c^2}, \qquad \mathcal{E}_n = hf_n \quad \text{when a frequency channel is defined.} \tag{123}$$

This is the Einstein–Planck mass-frequency bookkeeping channel. It is not a new law of particle masses.

9.2 Closure and persistence

Survival weighting expresses persistence through recurrence, closure, and clock-bearing structure. Let $\sim$ be an equivalence relation on recursive states. A history $\gamma = (\sigma_0, \sigma_1, \ldots)$ has recursive closure over m steps when

$$\sigma_{n+m} \sim \sigma_n. \tag{124}$$

It has an internal recurrent clock component C_n when a subsystem returns through equivalent states with a calibratable period. A rendered massive configuration in the QFT reconstruction above corresponds, under the survival-weighting bridge, to a history whose support and measure package remain coherent across enough recursive steps to satisfy the analogue of Eq. (74).

Bridge postulate R3: persistence correspondence. If a history γ_i preserves support X_n, measure data μ_n, and relevant sector quantum numbers across the interaction depth N_f, then it is survival-persistent over that depth. This is the recursive counterpart of τ_f-persistence.

9.3 Survival weighting

The survival-weighting law assigns accumulated loss

$$A_i(t) = \int_0^t \Gamma(\sigma_i(\tau))\, W(\varphi_i(\tau))\, \mathrm{d}\tau, \tag{125}$$

survival weight

$$S_i(t) = \exp[-A_i(t)], \tag{126}$$

and represented measure

$$p_i(t) = \frac{S_i(t)}{\sum_j S_j(t)} = \frac{\mathrm{e}^{-A_i(t)}}{\sum_j \mathrm{e}^{-A_j(t)}}. \tag{127}$$

Important separation. Equations (125)–(127) rank histories by survival representation. They do not by themselves create the Higgs Yukawa mass m_f, the QCD hadron mass M_H, or the invariant mass of a bound system. Those masses enter through μ_n using the sector formulae above.

9.4 Temporal transport from survival coherence

Temporal transport is not just motion through a coordinate. In the survival-weighting bridge it is the persistence of support, transport, measure, and survival coherence across recursive depth [26, 12]. For a history $\gamma_i = (\sigma_{i,0}, \sigma_{i,1}, \ldots)$, define a coherence condition over N steps by

$$\mathcal{T}_i(N) = 1 \quad \Longleftrightarrow \quad \begin{aligned} & X_{i,k} \sim_X X_{i,0}, \\ & \mu_{i,k} \sim_\mu \mu_{i,0}, \\ & \varphi_{i,k} \text{ is transport-admissible}, \\ & S_{i,k} > S_{\min}, \qquad 0 \le k \le N. \end{aligned} \tag{128}$$

Here the equivalence relations and the threshold $S_{\min}$ must be fixed by the model. The condition says that a history becomes temporally transportable when the support remains identifiable, the measure data remain attached, the phase or transport component remains admissible, and the survival weight does not fall below the represented threshold.

The light-like limit is the special transport class in which effective survival loss vanishes, the projected norm is preserved, and no recurrent internal clock is carried:

$$\Gamma W \to 0, \qquad J_{n+1} = J_n, \qquad dN_R = 0, \qquad d\tau_R = T_R\, dN_R = 0. \tag{129}$$

After a Lorentzian interval calibration is imported, this class is represented by $ds^2 = 0$. The matter-like temporal class is complementary. In this formalism, matter-like readout is classified by the simultaneous presence of support, closure or recurrence, measure data, and either non-zero recursive proper time or survival-selected persistence:

$$\text{matter-like temporal transport} \Longleftrightarrow \\ X_n + \mu_n + (d\tau_R > 0 \text{ or } \mathcal{T}_i(N) = 1) \quad \text{under a declared bridge.}$$

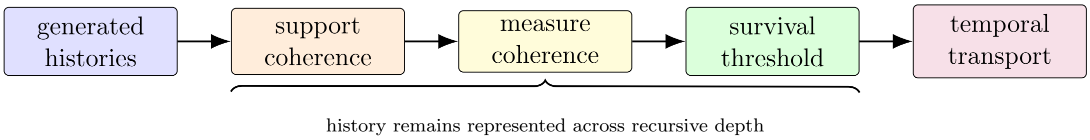

Figure 16: Survival-to-temporal-transport funnel. A generated history becomes temporally transportable only when support, measure, transport, and survival coherence persist across the chosen recursive depth.

9.5 Future bridge: survival-coupled matter weighting

If a future model wants survival weighting to affect the representation of mass-bearing histories directly, it must add an explicit bridge law. A minimal symbolic example is

$$A_i^{\text{matter}}(t) = \int_0^t \left[\Gamma_i W_i + \beta_M \, \mathcal{F}(M_{\text{eff},i}, X_i, \varphi_i)\right] \mathrm{d}\tau,$$

where β_M and $\mathcal{F}$ must be fixed independently before comparison with data. Without such independent specification, the extra term is only notation and is not part of the core rendering criterion.

No hidden identification. $\Lambda_{\text{surv}} = \Gamma W$ is an effective survival-loss rate in the survival-weighting formalism. It is not the cosmological constant, not a Higgs mass term, not a QCD confinement term, and not a replacement for stress-energy.

9.6 Conditional survival-weighting embedding lemma

Lemma. Given bridge postulates R1–R3, a QFT-rendered configuration C corresponds to a survival-weighted matter-like state only if X_n carries localised support corresponding to stress-energy contrast, μ_n carries a sector-defined mass or mass-equivalent measure, the history preserves support and measure data over the required interaction depth, and survival weighting, if used, is applied to represented histories rather than mistaken for the origin of the sector mass.

Proof. R1 maps localisation into support. R2 places sector-defined energy, momentum, and mass data into μ_n. R3 maps persistence into recursive closure or coherence over the relevant depth. Equation (127) then normalises survival weights over histories. None of these steps changes the sector formulae (101), (107), (109), or (114); therefore the structured recursive state is matter-like exactly when support, persistence, and sector measure data are all present. □

10 Moving Support and Gravitational-Wave Readout

The Surtea-Austin corpus also contains a motion claim that the narrow draft did not express. A support can remain recursively stable while its transport data change. In one frame the support may appear as a stable object because $X_{n+k} \sim_X X_n$, while in an exterior embedding its measure and transport data may produce a time-dependent stress-energy readout [26, 5]. This is the relevant place for gravitational-wave terminology, but it must be kept under a strict guardrail.

In standard GR, gravitational radiation is not produced by mere constant motion. In a weak-field far-zone reading, the radiative strain is controlled schematically by the second time derivative of the transverse-traceless quadrupole moment,

$$h_{ij}^{\mathrm{TT}}(t, \mathbf{x}) \sim \frac{2G}{c^4 R} \frac{\mathrm{d}^2 Q_{ij}^{\mathrm{TT}}(t - R/c)}{\mathrm{d}t^2}, \tag{130}$$

and radiated power is controlled by third derivatives of the quadrupole,

$$P_{\mathrm{GW}} = \frac{G}{5c^5} \left\langle \frac{\mathrm{d}^3 Q_{ij}}{\mathrm{d}t^3} \frac{\mathrm{d}^3 Q_{ij}}{\mathrm{d}t^3} \right\rangle. \tag{131}$$

The survival-weighting bridge can therefore say this, and no more without an embedding: a moving support with stable recursive identity can produce a gravitational-wave readout only when its embedded stress-energy has the required time-dependent multipole structure. The bridge condition is

$$X_{n+k} \sim_X X_n \quad \text{and} \quad \frac{\mathrm{d}^2 Q_{ij}^{\mathrm{TT}}}{\mathrm{d}t^2} \neq 0 \quad \Longrightarrow \quad \text{possible exterior gravitational-wave readout.} \tag{132}$$

The first condition supplies support stability. The second supplies the standard physical radiation condition. Constant inertial motion of an unchanging isolated support does not satisfy the second condition and is not by itself a gravitational-wave source.

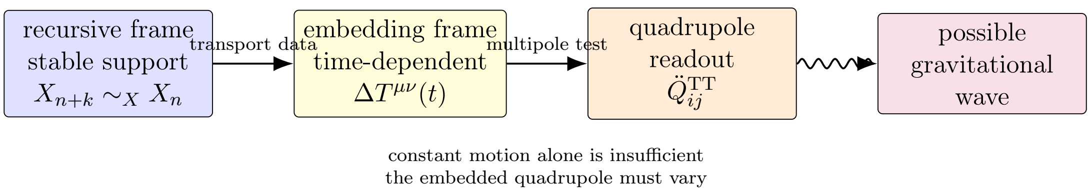

Figure 17: Moving-support readout. Recursive support stability and exterior time-dependent stress-energy are distinct conditions; gravitational-wave terminology is justified only after the standard multipole condition is met.

11 Illustrative Scale Estimates

The gravitational guardrail is not merely philosophical. A useful upper-bound estimate for the strain from a persistent localised structure with effective mass M_{eff}, characteristic size L, characteristic speed v, and observer distance r is

$$h \sim \frac{2G}{c^4 r} \ddot{Q} \sim \frac{2G M_{\mathrm{eff}} L^2 \omega^2}{c^4 r} \sim \frac{2G M_{\mathrm{eff}} v^2}{c^4 r}. \tag{133}$$

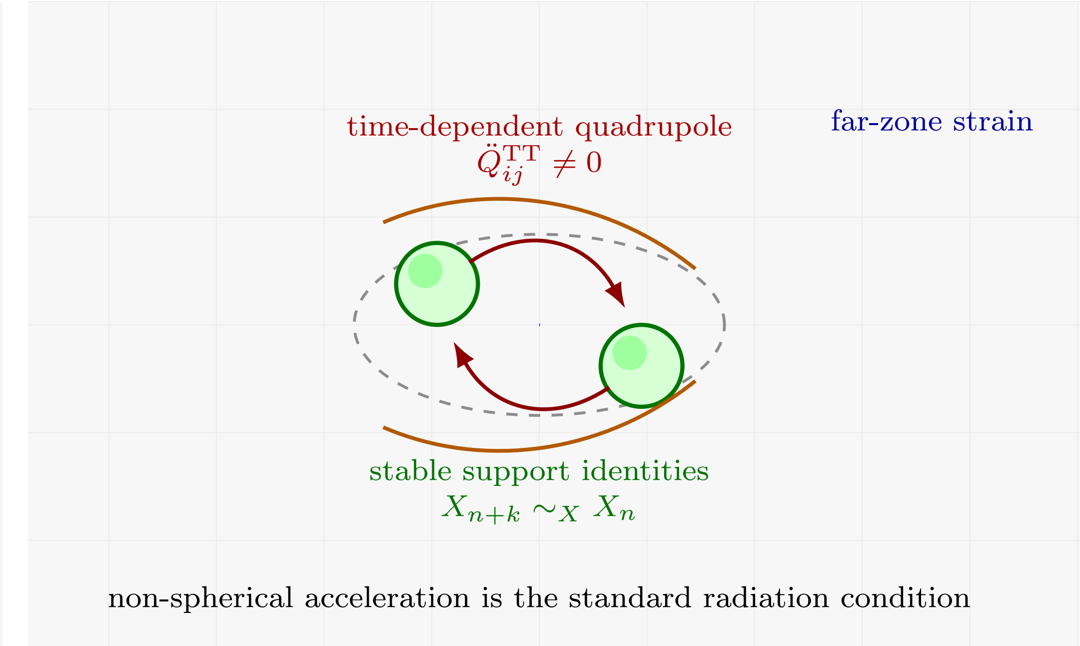

Figure 18: Quadrupole readout scene. Stable support may persist through motion, but gravitational-wave output requires a changing non-spherical stress-energy moment, not support or motion alone.

This estimate vanishes at leading order for static spherical support and is relevant only for non-spherical time-dependent motion. For a proton-scale rendered structure with $M_{\mathrm{eff}} \approx 1.67 \times 10^{-27}\,\mathrm{kg}$, relativistic internal motion $v \sim c$, and a far-zone observer at $r = 1\,\mathrm{m}$, the scale is

$$h \sim \frac{2GM_{\mathrm{eff}}}{c^2 r} \approx 2.5 \times 10^{-54}. \tag{134}$$

The lesson is conservative. Microscopic rendered support gravitates through stress-energy, but it is far too small to produce measurable gravitational waves unless enormous coherent masses move quadrupolarly.

For black-hole mass growth by captured photons, the bookkeeping is simpler. If radiation of absorbed exterior energy E_{abs} enters the horizon, then

$$\Delta M_{\mathrm{BH}} = \frac{E_{\mathrm{abs}}}{c^2}. \tag{135}$$

A single 1 eV photon contributes

$$\Delta M_{\mathrm{BH}} \approx \frac{1.60 \times 10^{-19}\,\mathrm{J}}{(3.00 \times 10^8\,\mathrm{m\,s^{-1}})^2} \approx 1.8 \times 10^{-36}\,\mathrm{kg}, \tag{136}$$

while a fully absorbed 1 GJ radiation pulse contributes

$$\Delta M_{\mathrm{BH}} \approx \frac{10^9\,\mathrm{J}}{c^2} \approx 1.1 \times 10^{-8}\,\mathrm{kg}. \tag{137}$$

For a Schwarzschild black hole in the geometric-optics capture regime, with $r_s = 2GM/c^2$, the high-frequency capture cross-section is

$$\sigma_{\mathrm{abs}} \approx \frac{27\pi G^2 M^2}{c^4} = \frac{27\pi}{4} r_s^2. \tag{138}$$

For $M = M_\odot$, $r_s \approx 2.95\,\text{km}$, giving

$$\sigma_{\text{abs}} \approx 1.8 \times 10^8\,\text{m}^2. \tag{139}$$

The corresponding mass-growth estimate for a photon flux F in the capture regime is

$$\dot{M}_{\text{BH}} \approx \frac{\sigma_{\text{abs}} F}{c^2}. \tag{140}$$

For rotating black holes, superradiant modes and angular-momentum bookkeeping must be treated mode by mode. For astrophysical black holes, Hawking emission is usually negligible compared with ordinary accretion or radiative capture.

12 Vacuum Stress-Energy Guardrails

12.1 Uniform vacuum stress-energy

Standard identity. A Lorentz-invariant vacuum contribution has the stress-energy form

$$T^{\mu\nu}_{\text{vac}} = -\rho_{\text{vac}} g^{\mu\nu}. \tag{141}$$

Such a component is uniform and frame-independent. It does not define a localised support X, does not cluster as ordinary matter, and does not produce a local contrast object in the rendering sense. In general relativity it contributes, if retained, as a cosmological-constant-like term:

$$\Lambda_{\text{CC}} = \frac{8\pi G}{c^4} \rho_{\text{vac}} \quad \text{up to sign convention.} \tag{142}$$

This is the standard cosmological-constant guardrail rather than a solution of the vacuum-energy problem [27, 28].

Rendering interpretation. The uniform vacuum is unrendered relative to local matter bookkeeping because it lacks localised contrast. A localised vacuum perturbation, boundary-condition difference, or particle excitation can be rendered because it does carry contrast over a support. The guardrail is therefore simple: a uniform substrate and a localised rendered configuration are not interchangeable.

12.2 Casimir-type perturbations

Casimir configurations illustrate the guardrail [29, 30]. Boundary conditions alter the vacuum mode structure between conducting plates, producing a measurable force. This is a localised contrast in vacuum configuration, but it is not therefore a stable particle or a hadron. In the present notation it may satisfy a support condition for a stress-energy difference,

$$\Delta T^{\mu\nu}_{\text{Casimir}} = T^{\mu\nu}_{\text{plates}} - T^{\mu\nu}_{\text{free}}, \tag{143}$$

while failing the sector conditions Q_C for matter-particle rendering. This is why rendering needs support, sector closure, and accessibility.

12.3 Cosmological-constant separation

The survival-weighting loss rate and the cosmological constant have different mathematical types:

$$\Lambda_{\text{surv}} = \Gamma W \quad [\text{time}^{-1}] \qquad \text{while} \qquad \Lambda_{\text{CC}} \quad [\text{length}^{-2}]. \tag{144}$$

They can be related only by an additional physical bridge specifying an energy scale, a coarse-graining volume, a stress-energy tensor, conservation, and an equation of state. This note does not supply such a completed bridge.

13 Limits, Failure Modes, and What Is Not Established

13.1 What is established

This note establishes a limited structural classification. In this formalism, rendered matter-like readout is classified by the simultaneous presence of energy valuation, relation vectors, survival-selected paths, Surtea support, transport, measure, and survival coherence. The formula is not a new dynamical law. It says where mass-facing or matter-like readout lives once an energy-bearing system, standard sector dynamics, conservation laws, and bridge conditions have supplied the required measures. It does not replace those dynamics.

13.2 What is not established

The note does not calculate numerical values of Yukawa couplings, the electron mass, quark masses, proton mass, or Higgs mass from first principles. It does not establish the hierarchy between the electroweak and Planck scales, a new QCD confinement proof, a new gravitational field equation, the observed value of the cosmological constant, a new gravitational-wave source law, or a new cross-section, decay rate, or scattering amplitude.

The present note supplies classifications, embeddings, and consistency guardrails; it does not produce a new independently testable numerical prediction until a bridge coefficient, conservation law, and observable are fixed before comparison.

13.3 Failure modes

The rendering criterion fails or becomes empty if support and persistence thresholds are chosen after the result is known; if the energy sites, relation vectors, or path-survival functional are fitted after the desired support has already been chosen; if energy-equivalent mass E/c^2 is confused with invariant rest mass; if a photon is described as having rest mass because it has energy; if Λ_{surv} is identified with Λ_{CC} without an independent stress-energy bridge; if supported vacuum measure is said to gravitate without a conserved $T^{\mu\nu}_{R,X}$; if survival weighting is used to fit particle masses after the fact; if the measure package μ_n is treated as a mass source rather than as the place where standard sector measures are stored; if constant motion is treated as sufficient for gravitational radiation without the required time-dependent multipole readout; if black-hole absorption is described as preserving the exterior carrier history after horizon crossing; or if rendering terminology is treated as a new force rather than a structural classification of configurations.

13.4 Acceptance criteria for future strengthening

A stronger theory of mass as rendering would need at least one additional ingredient: an independently specified microscopic rule calculating a sector mass parameter rather than storing it, a survival-coupled matter bridge with fixed coefficients and falsifiable predictions, a gauge- and Lorentz-covariant formulation of rendering scores that does not depend on arbitrary observer choices beyond the operational context, or a cosmological vacuum bridge that produces a conserved stress-energy sector with an independently justified equation of state.

14 Conclusion

The formal reconstruction is broader than the initial draft: mass-facing readout begins with an energy-bearing vacuum system rather than with an already-formed object. Energy valuation supplies sites. Relation vectors connect those sites once a frame or embedding is declared. Survival weighting selects the paths that remain best represented. The closure of those selected paths constructs the Surtea support. Boundary valuation then supplies exposure, recursive phase transport supplies motion data, and QFT supplies the stress-energy and sector mass budgets. Maxwell and quantisation supply light-like energy propagation through the frame-limited case $d\tau_R \to 0$, interaction closure supplies pair-production matter channels, and black-hole bookkeeping supplies a useful guardrail showing that light can update mass through E_γ/c^2 without having rest mass. The strongest conditional bridge proposed here is therefore conservative: a declared support-gated effective sector may contribute to gravity only when represented as conserved stress-energy; the resulting metric shapes light-like transport; frequency-energy then enters μ_n; and matter-like representation appears only when standard interaction channels produce support-bearing massive excitations or when a horizon support assimilates conserved measure.

Higgs coupling, QCD confinement, bound-system invariant mass, light-to-matter conversion, and black-hole absorption remain mechanistically distinct. They become structurally unified because each supplies or preserves a measure on a support-bearing history. The survival law ranks histories; it does not secretly replace the Higgs sector, QCD, invariant mass, Maxwell theory, pair production, or GR horizon bookkeeping. Within the rendering interpretation, matter is represented as localised persistent stress-energy contrast. The formal result is energy valuation, relation-vector support, persistence, and sector-defined stress-energy measure.

Acknowledgements

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