Appendix

Appendix A.1–A.3: CUWF ⟷ QFT Dictionary, Minimal Equations, and Glossary

Purpose of the Appendix

This appendix provides a compact reference structure for Paper A-19. Its purpose is not to introduce a new argument, but to consolidate the central translations, minimal mathematical expressions, and core terminology used throughout the paper. The appendix should be read as a navigation tool for readers moving between standard QFT language and the CUWF interpretation of fields, particles, vacuum, interaction, renormalization, and measurement.

A.1 CUWF ⟷ QFT Dictionary

The following dictionary summarizes the main conceptual translation developed in Paper A-19. The QFT terms are retained operationally, while CUWF relocates their ontology to entropic mode space, resonance stabilization, and spacetime projection.

QFT term / structure	CUWF interpretation	Physical meaning in Paper A-19
vacuum $\|0\rangle$	baseline entropic mode sea $\|\mathcal{V}\_E\rangle$	The vacuum is not nothing. It is the non-resonant baseline population of admissible entropic modes.
field operator $\phi(x)$	projection of mode amplitudes and phases	A spacetime-local field is a projected representation of the underlying entropic wave field $\mathcal{F}$.
field excitation	temporary or stable resonance activation	An excitation is a mode-space coherence event that may or may not become a persistent particle identity.

QFT term / structure	CUWF interpretation	Physical meaning in Paper A-19
particle	stable collapse resonance $\Omega_R \subset \mathcal{F}$	A particle is not separate from the field. It is a collapse-stabilized, phase-locked resonance subset.
creation operator a†	resonance formation operator	Creation means stabilization of a resonance identity from the baseline mode sea.
annihilation operator a	resonance dissolution operator	Annihilation means return of resonance coherence to the vacuum reservoir.
occupation number N	resonance occupation count	The number operator counts stable resonance identities, not tiny point objects.
commutation relations	projected algebra of resonance compatibility	Commutation or anticommutation emerges from mode indistinguishability, phase coherence rules, and entropic compatibility.
boson	additive resonance occupancy	Bosonic resonances can stack because their phase-lock structures are mutually compatible.
fermion	entropic phase-lock exclusion	Fermionic exclusion arises because identical same-state resonance occupation is entropically incompatible.
propagator	mode correlation transport kernel	Propagation is transport of coherence and correlation in mode space, projected into spacetime.
vertex	resonance transition node	A Feynman vertex is bookkeeping for an admissible resonance reconfiguration under entropic coupling.

QFT term / structure	CUWF interpretation	Physical meaning in Paper A-19
coupling constant g	effective entropic coupling strength	The coupling constant is the projected strength of coupling between specific resonance-capable mode families.
gauge field	phase-alignment connection	Gauge structure expresses redundancy in the description of phase alignment across modes.
gauge boson	mediator resonance of phase correction	A gauge boson carries or restores phase compatibility between interacting resonance structures.
photon	traveling coherence packet	The photon is a mobile phase-correction resonance in the entropic mode sea.
charge	topological phase-gradient / coupling signature	Charge is an invariant of resonance geometry, preserved across admissible transitions.
zero-point energy	baseline fluctuation energy of the mode sea	Zero-point energy is not energy of empty space; it is fluctuation activity of $\lvert \mathcal{V}$_E⟩.
vacuum polarization	mode rearrangement around resonance	The vacuum changes because the baseline mode sea redistributes around a resonance or imposed field.
renormalization	coarse-graining of mode space	Renormalization compensates for the hidden entropic cutoff and unresolved mode structure in QFT.
running coupling	scale-dependent entropic coupling	Couplings run because different mode layers become visible or suppressed at different scales.

QFT term / structure	CUWF interpretation	Physical meaning in Paper A-19
QFT limit	quasi-linear projection of CUWF	QFT is recovered when entropic curvature is weak, vacuum is stable, and interactions are perturbative.

A.2 Minimal Set of Equations

This subsection collects the minimal mathematical structure required to preserve the logical core of Paper A-19. The equations are not intended to replace the detailed development in the main text. They function as the compact mathematical spine of the paper.

A.2.1 Entropic Wave Field and Mode-Space Representation

The CUWF field is an entropically admissible ensemble of modes, not a primitive spacetime field:

$$\mathcal{F} = \{ m_i \in \mathcal{M} \mid C\_E(m_i) \leq 0 \}$$

The corresponding field state in mode space is represented as:

$$|\Psi\rangle = \Sigma_i c_i |m_i\rangle, \qquad c_i = A_i e\^\{i\phi_i\}$$

This captures both the amplitude distribution and the phase organization of the entropic wave field.

A.2.2 Projection to the QFT Field Operator

The QFT field operator is an effective spacetime projection of the underlying mode state:

$$\phi(x) = \Pi\_x(\mathcal{F}) = \Pi\_x(|\Psi\rangle)$$

A mode expansion form of the same projection is:

$$\phi(x) = \Sigma_i c_i \phi_i(x)$$

Here $\phi_i(x)$ are projected basis functions. Spacetime locality belongs to the projection, not to the deepest ontology.

A.2.3 Master Entropic Wave Equation

A minimal schematic master equation for CUWF field evolution may be written as a constrained entropic mode-space dynamics:

$$D_\lambda \Psi = \kappa_E \Delta_E \Psi + i\, \Omega_E(\Psi, g_E, \mathcal{K}_E) - \Gamma_E(\Psi, C_E)$$

where D_λ is the evolution derivative, Δ_E is the entropic Laplacian, κ_E is the entropic propagation coefficient, Ω_E represents phase/coherence transport and coupling rotation, and Γ_E represents damping, restructuring, or compatibility enforcement. This compact form expresses the dual CUWF structure: diffusion-like redistribution plus phase-coherence transport under entropic constraints.

A.2.4 Entropic Laplacian

For a scalar functional f on entropic mode space ($\mathcal{M}$, g_E), the entropic Laplacian is:

$$\Delta_E f = \mathrm{div}_E(\mathrm{grad}_E f)$$

$$\Delta_E f = (1 / \sqrt{|g_E|})\, \partial_a(\sqrt{|g_E|}\, g_E^{ab}\, \partial_b f)$$

This operator governs coherence spreading, correlation transport, and mode-space propagation prior to spacetime projection.

A.2.5 Entropic Action Principle

The mode-space field dynamics can be derived from an entropic action:

$$S_E[\mathcal{F}] = \int L_E(\mathcal{F}, D_\lambda \mathcal{F}; g_E, w)\, d\lambda$$

With constraints included:

$$S_E^c[\mathcal{F}] = \int [\, L_E(\mathcal{F}, D_\lambda \mathcal{F}) + \Sigma_k\, \alpha_k(\lambda)\, C_k[\mathcal{F}]\,]\, d\lambda$$

The field equation follows from:

$$\delta S_E^c = 0$$

A.2.6 Resonance Stability Condition

A collapse-stabilized resonance Ω_R exists only when coherence, phase-locking, confinement, and stability conditions are jointly satisfied:

$R(\Omega) = |\Sigma_{i\in\Omega} A_i e^{i\phi_i}| / \Sigma_{i\in\Omega} A_i \geq R_*$

$d/d\lambda(\Delta\phi_{ij}) \approx 0, \quad \text{for } i, j \in \Omega$

$\Omega \subset \mathcal{B}_E, \quad C_E(\Omega) \leq 0$

For persistence of particle identity, the resonance must also satisfy:

$| d/d\lambda(\Delta\phi_{ij}) | \leq \varepsilon_{lock}$

$J_{out} \leq J_*, \quad dE_\Omega/d\lambda \geq -\gamma_*$

$D_\Phi(\Delta\lambda) \leq \Phi_*$

These equations encode the CUWF claim that particle identity is stable phase-locked resonance identity.

A.2.7 Particle Properties as Resonance Invariants

Mass, charge, and spin are interpreted as resonance invariants:

$m \propto \delta^2 S_E / \delta(\delta_E)^2 \quad \text{evaluated on } \Omega_R$

$Q = (1 / 2\pi) \oint_\Gamma d\Phi$

spin $\leftrightarrow$ representation of $\mathcal{G}_{rot}$ acting on Ω_R

Mass corresponds to stiffness against entropic deformation, charge to topological phase winding, and spin to rotational symmetry of the resonance manifold.

A.2.8 Vacuum and Zero-Point Structure

The CUWF vacuum is the baseline non-resonant mode sea:

$|0\rangle \approx \Pi_{QFT}(|\mathcal{V}_E\rangle)$

$N_R(\mathcal{V}_E) = 0, \quad \rho_{mode}(\mathcal{V}_E) > 0$

Zero-point energy is baseline fluctuation energy of that mode sea:

$E_{ZP}^{CUWF} = E_{fluc}(\mathcal{V}_E)$

$E_{ZP}^{CUWF} \sim \int (1/2)\hbar\omega(E)\, w(E)\, d\mu(E)$

The entropic weighting w(E) prevents the vacuum from being treated as an unrestricted continuum of all formal modes.

A.2.9 Interaction, Vertex, and Gauge Structure

Interaction is entropic coupling between resonance-supporting mode families:

$$g_{AB} = \Pi_{QFT}[\mathcal{K}_E(\Omega_A, \Omega_B)]$$

A QFT vertex is a projected resonance transition:

$$V_{QFT} = \Pi_{QFT}[\mathcal{T}_E(\Omega_{in} \longrightarrow \Omega_{out})]$$

Gauge fields and gauge bosons are interpreted as phase-alignment connection and phase-correction resonance:

$$A_\mu = \Pi_{QFT}(\mathcal{A}_E)$$

$$\Omega_A \oplus \Omega_B \longrightarrow_{\{\Omega_G\}} \Omega_A' \oplus \Omega_B'$$

A.2.10 Effective QFT Limit Derivation Sketch

QFT is recovered when CUWF dynamics enter a quasi-linear, weak-curvature, stable-vacuum regime:

$$QFT \approx \Pi_{QFT}(CUWF) \text{ under } \{ \text{quasi-linear regime, weak entropic curvature, stable vacuum} \}$$

In this limit:

mode dynamics linearize into oscillator-like projected field modes;

collapse turbulence becomes negligible;

the vacuum reservoir behaves as a stable background;

entropic coupling becomes perturbative;

resonance transitions can be represented by Feynman-diagram bookkeeping.

Schematically:

$$D_\lambda \Psi \approx \text{linear oscillator dynamics} \Rightarrow \phi(x) \text{ behaves as a QFT field}$$

$$\mathcal{K}_E \text{ small} \Rightarrow \text{interactions become perturbative}$$

$$\mathcal{A}_{QFT} \approx \Sigma \text{ diagrams } \Pi_{QFT}[\text{resonance transition pathways}]$$

Thus, QFT is not rejected. It is recovered as the effective spacetime-operator representation of CUWF resonance dynamics under the appropriate projection conditions.

A.3 Glossary

This glossary defines the principal terms used in Paper A-19. The definitions are specific to the CUWF framework and should be read in that context.

Term	CUWF meaning
Admissible mode	A wave mode that satisfies the entropic compatibility condition $C\_E(m_i) \leq 0$ and can therefore participate in the physical CUWF field.
Baseline entropic mode sea	The non-resonant vacuum background $|\mathcal{V}\_E\rangle$ containing admissible modes, phase fluctuations, and latent resonance capacity.
Boson	A resonance family with additive occupancy. Multiple identical bosonic resonances can coexist because their phase-lock structures are compatible.
Collapse	A physical stabilization process in which unstable phase relations among modes become locked into a persistent resonance structure.
Collapse resonance	A stable phase-locked mode subset Ω_R produced by collapse-stabilization. This is the CUWF interpretation of particle identity.
Collapse turbulence	A regime of unstable or strongly nonlinear resonance formation and dissolution, where QFT projection may fail.

Term	CUWF meaning
Commutation relations	Effective algebraic rules arising from resonance compatibility, mode indistinguishability, and phase-coherence constraints.
Coupling constant	A projected parameter measuring the effective entropic coupling strength between resonance-capable mode families.
Detector	A macroscopic resonance stabilizer that biases the entropic mode field toward one stable outcome configuration during measurement.
Entropic compatibility	The condition that a mode or resonance configuration remains physically admissible within the constraints of entropic mode geometry.
Entropic coupling curvature	Curvature in the mode-coupling structure that shapes field propagation, resonance stability, and the projected appearance of gravity.
Entropic curvature scale	The scale E_E beyond which the quasi-linear QFT projection fails and mode density becomes suppressed by entropic geometry.
Entropic Laplacian	The Laplace-like operator Δ_E compatible with entropic mode geometry, governing mode-space spreading and correlation transport.
Entropic mode space $\mathcal{M}$	The Hilbert-like but entropically weighted space in which CUWF field states live before spacetime projection.

Term	CUWF meaning
Entropic reservoir	The vacuum understood as a background mode reservoir from which coherence can be drawn into particle production and to which coherence can return during annihilation.
Entropic wave field $\mathcal{F}$	An ensemble of physically admissible entropic wave modes. It is the CUWF counterpart underlying projected QFT fields.
Fermion	A resonance family whose identical same-state occupancy is forbidden by entropic phase-lock incompatibility.
Field operator $\phi(x)$	The QFT spacetime-local field operator, reinterpreted in CUWF as a projection of mode amplitudes and phases.
Feynman diagram	A projected bookkeeping device for resonance transition pathways in the quasi-linear QFT regime.
Gauge boson	A mediator resonance of phase correction, supporting phase compatibility between interacting resonance structures.
Gauge field	The projected representation of a phase-alignment connection in entropic mode space.
Gauge symmetry	Redundancy in the description of phase alignment across modes, not absence of physical phase-connection structure.

Term	CUWF meaning
Mode	A basic entropic wave component mᵢ characterized by amplitude, phase, and compatibility with g_E.
Mode coarse-graining	The averaging or suppression of unresolved entropic mode layers, appearing in QFT as renormalization group flow.
Mode correlation transport kernel	The CUWF interpretation of a propagator: a kernel describing transport of correlation and coherence through mode space.
Particle	A stable collapse resonance Ω_R, not a point-object separate from the field.
Phase alignment	The preservation or correction of relative phase relations among coupled mode families.
Phase-lock rule	The CUWF rule determining whether multiple resonance structures can coexist in the same entropic basin.
Photon	A traveling bosonic coherence packet in the entropic mode sea, functioning as electromagnetic phase-correction transport.
Projection Π_QFT	The mapping from CUWF mode-space dynamics into the effective spacetime-operator language of QFT.
QFT limit	The regime where CUWF dynamics become quasi-linear, entropic curvature is weak, vacuum is stable, and interactions are perturbative.

Term	CUWF meaning
Renormalization	The effective correction and parameter flow required when projected QFT hides the natural entropic cutoff and mode-selection structure.
Resonance	A coherent, phase-locked configuration of modes capable of persistence as an identity.
Resonance transition node	The CUWF meaning of a QFT vertex: an admissible reconfiguration of resonance structures under entropic coupling.
Running coupling	Scale-dependent projected entropic coupling strength.
Stable background vacuum	A vacuum reservoir whose baseline mode structure remains sufficiently steady for QFT projection to hold.
Vacuum polarization	Rearrangement of the baseline mode sea around a resonance or imposed coherence disturbance.
Vacuum reservoir	The non-empty baseline mode population supporting coherence withdrawal, coherence return, vacuum polarization, and particle production.
Zero-point energy	Baseline fluctuation energy of the entropic mode sea, not energy of empty space.