Section 2 CUWF Postulates for Quantum Fields

2.1 Definition: Entropic Wave Field $\mathcal{F}$

In standard Quantum Field Theory (QFT), a field is typically introduced as a function or an operator-valued distribution on spacetime, e.g., $\phi(x)$, where x denotes a spacetime point. This formulation is operationally successful, yet it implicitly assumes that spacetime is the primary domain upon which the fundamental degrees of freedom are defined.

The CUWF framework reverses this assumption. In CUWF, spacetime is not treated as the deepest layer of ontology. Instead, it is regarded as an emergent domain—an effective coordinate representation arising from the organization, coupling, and stabilization of deeper wave structures. Consequently, the CUWF concept of a “field” cannot be defined as a primitive object on spacetime. It must be defined at the deeper structural level from which spacetime representations are derived.

This section introduces the formal CUWF definition of a quantum field as an entropic wave field, denoted by $\mathcal{F}$.

2.1.1 Formal Definition

Definition 2.1 (Entropic Wave Field).

An Entropic Wave Field, denoted by $\mathcal{F}$, is defined as

a physically admissible ensemble of wave modes whose existence and dynamics are constrained by entropic compatibility conditions, evolving primarily in a mode space (rather than directly on spacetime).

Formally, we represent $\mathcal{F}$ as a set (or structured ensemble) of modes

$$\mathcal{F} = \{ m_i \mid m_i \in \mathcal{M}, i \in I \}$$

where

m_i is the i-th wave mode,

$\mathcal{M}$ is the mode space of the CUWF system (Hilbert-like in structure but entropically weighted),

I is the index set of modes that are physically admissible within the CUWF constraints.

The key conceptual point is:

In CUWF, a field is not “a value at a point in spacetime”; it is a structured population of admissible wave modes.

2.1.2 Why $\mathcal{F}$ is Not a Primitive Spacetime Object

Defining a field directly as $\phi(x)$ presupposes that spacetime is the correct fundamental substrate. However, CUWF is built on the premise that spacetime itself emerges from the entropic organization of wave dynamics. If spacetime is emergent, then any field defined directly on spacetime is necessarily a projected or derived object.

Thus, CUWF adopts the following ontological ordering:

entropic mode structure ⟶ spacetime projection ⟶ spacetime field representation

and not the reverse.

Accordingly,

$\mathcal{F}$ is not defined on spacetime; rather, spacetime field representations are derived from $\mathcal{F}$ through projection.

2.1.3 Fields as Mode Ensembles Under Entropic Constraints

The defining feature of $\mathcal{F}$ is the presence of entropic constraints. These constraints are not rhetorical; they serve as explicit admissibility conditions determining which modes can exist as persistent physical degrees of freedom.

Let $S[\Psi]$ (or equivalently $S[\mathcal{F}]$) denote an entropy functional governing admissibility and stability in the CUWF system. Then, for each mode m_i, define an entropic compatibility constraint

$C_E(m_i)$

such that only modes satisfying an admissibility condition belong to $\mathcal{F}$. We may represent this schematically as

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

Modes violating entropic compatibility ($C_E(m_i) > 0$) are not physically stable in the CUWF sense: they cannot persist as coherent components of the field and therefore do not constitute elements of $\mathcal{F}$.

This mechanism implies that:

CUWF fields are not arbitrary superpositions of all imaginable waves; they are entropically filtered ensembles of physically admissible modes.

2.1.4 Physical Interpretation: Field as “Mode Population Structure”

In QFT, “the field” is often treated as a spacetime object whose excitations correspond to particles. CUWF proposes a deeper interpretation:

A field is best understood as a mode population structure, defined by

the set of admissible modes,

their amplitude distribution,

their coupling topology,

and their phase-coherence organization.

In this view, the essential content of “field” is not $\phi(x)$ itself, but the structured distribution of wave-mode degrees of freedom that can later be read or represented as $\phi(x)$ in spacetime coordinates.

2.1.5 Bridge Statement: QFT Fields as Projections of $\mathcal{F}$

To maintain explicit continuity with QFT, CUWF does not deny the utility of spacetime fields. Instead, it asserts that the QFT field $\phi(x)$ is a projection of the underlying entropic wave field $\mathcal{F}$ onto the spacetime domain.

We express this as: $\phi(x) = \Pi_x(\mathcal{F})$

where

Π_x is a projection operator mapping the entropic mode ensemble to a spacetime-local field representation.

The precise structure of Π_x will be developed later (Sections 3 and 5), where we show how standard operator structures in QFT can emerge as effective approximations of mode dynamics in CUWF.

Summary (Section 2.1)

CUWF defines a quantum field as an Entropic Wave Field $\mathcal{F}$: an entropically admissible ensemble of wave modes in mode space.

$\mathcal{F}$ is not defined as a primitive object on spacetime.

Entropic constraints filter admissible modes and provide a physical stability criterion.

The usual QFT field $\phi(x)$ arises as a projection of $\mathcal{F}$ onto spacetime coordinates:

$\phi(x) = \Pi_x(\mathcal{F})$

2.2 Fields as Entropic Wave Modes

Having defined the CUWF quantum field $\mathcal{F}$ as an entropically admissible ensemble of modes in mode space $\mathcal{M}$, we now specify the internal structure of those modes. In CUWF, the elementary constituents of a field are not spacetime-local “field values,” but wave modes characterized by amplitude–phase degrees of freedom. The field is therefore best understood as a structured population of such modes evolving under entropic constraints and entropic geometry.

2.2.1 Definition of a Mode

Definition 2.2 (Entropic Wave Mode).

An entropic wave mode m_i is an element of the mode space $\mathcal{M}$ with a well-defined amplitude A_i and phase ϕ_i, together with an entropic geometric structure that determines how the mode propagates, couples, and stabilizes.

We represent a mode as: $m_i \equiv (A_i, \phi_i \,;\, g\_E)$

where: $A_i \geq 0$ is the mode amplitude,

$\phi_i \in [0, 2\pi)$ is the mode phase,

g_E is the entropic metric (or entropic curvature structure) on $\mathcal{M}$.

In this formulation, A_i and ϕ_i are not merely mathematical parameters; they encode the physically relevant coherence content of each mode and allow resonance identities to emerge when phase relations become stable.

2.2.2 Mode Ensemble Representation of the Field

Given Definition 2.2, the CUWF field $\mathcal{F}$ can be represented as a mode ensemble:

$$\mathcal{F} = \{ m_i \} = \{ (A_i, \phi_i \,;\, g\_E) \} \quad \text{for } i \in I$$

Thus, the “state of a field” at a given stage of evolution is specified by the amplitude distribution $\{A_i\}$, the phase organization $\{\phi_i\}$, and the entropic geometry g_E that constrains admissible mode configurations.

This replaces the common QFT intuition that “the field is something assigned to each point x.” In CUWF, the primary object is the mode ensemble itself; spacetime representations arise only after projection.

2.2.3 Role of Entropic Geometry: Metric / Curvature g_E

A defining feature of CUWF modes is that their behavior is governed not only by amplitudes and phases, but also by an entropic geometric structure. We denote this structure by g_E and interpret it as an effective metric (and curvature) on mode space $\mathcal{M}$.

Conceptually: - g_E determines the "distance" between modes in entropic terms.

- g_E determines which modes can couple efficiently.

- g_E regulates stability and collapse-resonance formation by constraining compatible phase relations.

In standard QFT, the geometric structure is imposed externally through spacetime metrics (e.g., Minkowski or curved spacetime). In CUWF, the foundational geometry is entropic: g_E shapes the allowed mode interactions before any projection into spacetime coordinates.

We therefore treat g_E as a core primitive of CUWF field dynamics. In later sections (Section 3), it will be used to define entropic derivatives, propagation operators, and correlation kernels.

2.2.4 Practical Interpretation: Why Amplitude and Phase Matter

The amplitude–phase decomposition is not an aesthetic choice. It is required to support the CUWF claim that particles arise as stable collapse resonances.

- Amplitude A_i measures the intensity (population/coherence weight) of mode i.

- Phase ϕ_i determines interference, synchronization, and phase-locking.

Resonances correspond to persistent phase relations across subsets of modes. Therefore, a particle in CUWF is not "one mode," but an organized resonance substructure within the mode ensemble, stabilized by entropic constraints and shaped by g_E.

Summary (Section 2.2)

- CUWF fields are ensembles of entropic wave modes.

- Each mode m_i is characterized by amplitude A_i and phase ϕ_i.

- Mode evolution and coupling are governed by an entropic geometric structure (metric/curvature) g_E.

- This mode-based representation is the basis for defining collapse resonances (particles) in later sections.

2.3 Collapse-Stabilization Principle

In CUWF, the notion of “collapse” is not treated as an ad hoc interpretational add-on, nor as a purely epistemic update. Collapse is instead a physical dynamical process that transforms an unstable entropic mode configuration into a stabilized resonance structure. This stabilization mechanism is central to CUWF because it defines how particle-like identities emerge from fields understood as entropic wave modes.

The collapse-stabilization principle can be summarized by two key claims:

(1) Collapse is not disappearance; it is phase-locking.

(2) Stability corresponds to entropy-gradient minimization under constraints.

2.3.1 Collapse is Not Disappearance: It is Phase-Locking

In conventional quantum interpretations, the term “collapse” is often associated with a discontinuous loss of a superposition or an abrupt selection of an outcome. CUWF adopts a different meaning. Since CUWF fields are ensembles of modes characterized by amplitudes and phases (Section 2.2), collapse must be expressed in mode language.

Definition 2.3 (Collapse as Phase-Relation Locking).

A collapse event is a dynamical transition in which a subset of modes within $\boldsymbol{\mathcal{F}}$ evolves from an unstable configuration of phase relations into a stable configuration characterized by persistent phase coherence.

Thus, collapse is not the field "vanishing." Instead, collapse corresponds to a reorganization of phase relations:

- Before collapse: phases drift, interfere chaotically, and fail to maintain a persistent identity.
- During collapse: entropic coupling drives rapid adjustment of phase relations.
- After collapse: phases become locked into a stable pattern, enabling resonance identity.

In CUWF language, collapse is the process that converts a distributed mode population into a coherent resonance substructure.

2.3.2 Collapse as a Physical Stabilization Process

The CUWF field $\boldsymbol{\mathcal{F}}$ generally contains many admissible modes whose amplitudes and phases evolve dynamically. Most mode patterns are transient. A particle-like object is distinguished precisely by the persistence of its phase-locked structure over time.

Hence, in CUWF, "collapse" is not an exceptional process; it is the normal physical route by which coherent structures form.

Collapse-stabilization is therefore defined as:

- a reduction of phase disorder within a mode subset,
- the emergence of a robust resonance manifold,
- and the suppression of phase drift by entropic compatibility forces.

2.3.3 Stability Condition: Entropy-Gradient Minimization Under Constraints

The second component of the principle is a precise stability criterion.

Let S denote an entropy functional defined over the admissible mode configurations of $\mathcal{F}$. Collapse leads the system toward stable states in which entropic instability has been locally reduced.

We define the entropy gradient in mode space:

$$\nabla_E S \quad \text{(entropy gradient in entropic geometry } g_E\text{)}$$

A stabilized resonance corresponds to a configuration that minimizes the entropy gradient subject to the CUWF entropic constraints.

Stability Condition (Collapse-Stabilization Criterion).

A mode subset $\Omega \subset \mathcal{F}$ is said to be collapse-stabilized if it satisfies:

$$\text{minimize } \ \|\nabla_E S\| \quad \text{subject to } \ C_E(m_i) \leq 0 \quad \text{for all } m_i \in \Omega$$

Equivalently, in an idealized stationary form: $\nabla_E S = 0$ (within Ω, under constraints)

This condition means the following:

- the resonance is not an arbitrary arrangement of modes,
- it is the locally stable configuration permitted by entropic compatibility constraints,
- and its persistence results from being an entropy-gradient minimum in entropic geometry.

2.3.4 Interpretation: Particle Identity as a Stable Entropic Attractor

The collapse-stabilization principle introduces a crucial shift in ontology:

- In QFT, “particles” are quanta defined by field operator excitations.
- In CUWF, “particles” are stable attractors of phase-locked mode subsets driven by entropy-gradient minimization.

Thus, particle identity emerges as a consequence of stability in entropic mode dynamics. Collapse does not destroy the field; it reorganizes it into a coherent resonance structure.

This principle provides the foundation for later sections where we define particle formation conditions, lifetimes, and interaction behavior as resonance transitions rather than fundamental creation/annihilation events.

Summary (Section 2.3)

- Collapse in CUWF is a physical stabilization process, not disappearance.

- Collapse is formally interpreted as the locking of phase relations among a mode subset.

- Stability corresponds to entropy-gradient minimization under CUWF constraints:

minimize $||\nabla_E S||$ subject to $C_E \leq 0$

- Particle identity arises as a stable entropic attractor (phase-locked resonance).

2.4 Field Ontology in CUWF: What a Field “Really Is”

After defining the entropic wave field $\mathcal{F}$ as an admissible ensemble of modes (Section 2.1), specifying modes as amplitude–phase entities under entropic geometry g_E (Section 2.2), and introducing collapse as a phase-locking stabilization mechanism (Section 2.3), we can now state the CUWF ontology of fields explicitly.

In CUWF, a field is not an abstract spacetime function. A field is a physically real distribution of modes capable of forming collapse-stabilized resonances. This is the key ontological shift of Paper A-19.

2.4.1 Field as a Distribution of Resonance-Capable Modes

CUWF defines a field through the mode content and its resonance potential rather than through pointwise values in spacetime.

Definition 2.4 (Field Ontology).

A CUWF field is a distribution of resonance-capable entropic wave modes, i.e., a mode population whose internal structure permits collapse-stabilization into persistent resonance identities under entropic constraints.

In other words, a field is characterized by:

- which modes exist (admissible mode set I),
- their amplitude distribution $\{A_i\}$,
- their phase organization $\{\phi_i\}$,
- and their entropic coupling geometry g_E,

together with the crucial property:

- a subset of those modes can form collapse-stabilized resonances.

Therefore, the CUWF field is ontologically closer to a “reservoir of possible coherent identities” than to a spacetime-local quantity.

This allows CUWF to formalize a direct continuity between:

field ⟶ resonance formation ⟶ particle identity

without introducing particles as fundamental objects.

2.4.2 Resonance Capability and “Field Identity”

The term “resonance-capable” is essential. Not every admissible ensemble necessarily supports stable resonance identities. A CUWF field is defined not just by existence, but by its capacity to generate persistent coherence structures.

We denote the resonance-capable subset of modes as:

$$\mathcal{R}(\mathcal{F}) \subset \mathcal{F}$$

where $\mathcal{R}(\mathcal{F})$ contains modes and mode-relations that can satisfy the collapse-stabilization condition (Section 2.3).

This provides a physically meaningful basis for field classification:

- Different fields correspond to different resonance structures permitted by their mode distributions.
- “Field type” is therefore encoded in mode content and entropic coupling rules, not in spacetime labels.

This interpretation also prepares the ground for later sections where QFT particle species are reinterpreted as families of resonance solutions.

2.4.3 Vacuum as Baseline Mode Population (Non-Zero)

A second major ontological point follows immediately: vacuum is not empty.

In CUWF, vacuum is defined as the baseline mode population of the field: the minimal entropically admissible configuration that persists even in the absence of stable resonances (particles).

Definition 2.5 (CUWF Vacuum).

The CUWF vacuum is the non-zero baseline mode population of $\mathcal{F}$, representing the persistent entropic mode sea that remains when no collapse-stabilized resonance is present.

This implies:

- Vacuum is not “nothing,” but a physically real background mode distribution.
- The vacuum is non-zero because admissible modes exist even without resonance locking.
- Collapse-stabilized particles are resonance structures formed within this baseline mode sea.

Hence, the CUWF vacuum should not be interpreted as “empty spacetime.” It is a mode-space equilibrium configuration. Spacetime emptiness is therefore only a projected description; the underlying field remains populated by baseline modes.

2.4.4 Consequences for QFT Interpretation

This ontology reframes several standard QFT concepts:

- The vacuum state $|0\rangle$ is not empty; it corresponds to a non-zero baseline mode population.

- Field fluctuations are not mysterious; they are natural baseline dynamics of a populated mode sea.

- Particle creation/annihilation correspond to resonance formation/dissolution within the mode population, not to ontological creation of objects from nothing.

Therefore, CUWF offers a coherent ontological picture in which:

field = distribution of resonance-capable modes

vacuum = baseline non-zero mode population

QFT then becomes an effective formalism that successfully approximates projections of this ontology under quasi-linear conditions.

Summary (Section 2.4)

- In CUWF, a field is physically real: it is a distribution of resonance-capable modes in mode space.

- Particles are not fundamental; they are collapse-stabilized resonance identities supported by the field’s mode distribution.

- Vacuum is not emptiness; it is the baseline non-zero mode population (the mode sea) of $\mathcal{F}$.

- This ontology resolves the “creation from nothing” tension of QFT by interpreting creation/annihilation as resonance transitions.