Section 2. CUWF Preliminaries

This section introduces only those elements of the CUWF framework that are required to make Paper A-17 self-contained for first-time readers. The aim is not to restate the entire CUWF program, but to specify the minimal working substrate on which the charge–spin construction will be developed: (i) a complex field representation in which phase is treated as a structural variable, (ii) an entropic manifold governed by compatibility and stability constraints, and (iii) topological anchors, in the form of defects or collapse nodes, that support quantization and conserved classes.

2.1 Field Representation: Amplitude–Phase Decomposition

CUWF begins from the premise that the primary ontological object is a wave field whose physically meaningful degrees of freedom include both magnitude and phase. For the purposes of A-17, it is sufficient to represent the relevant local state of the field by a complex-valued scalar, or more precisely by an effective complex order parameter, written in polar form:

$$\Psi(x) = A(x) \cdot \exp(i\,\vartheta(x)),$$

where $A(x) \geq 0$ is the amplitude and $\theta(x)$ is the phase at the effective spacetime point x used in this paper. This representation is not introduced merely as mathematical shorthand. Within CUWF, the phase $\theta(x)$ is treated as a structural variable because it carries orientation in phase transport, because its gradients encode physically meaningful tensions or costs in the underlying field, and because its compatibility conditions naturally lead, at the effective level, to gauge-like descriptions.

Two clarifications are required. First, CUWF does not claim that all of reality is literally exhausted by a single complex scalar. The field $\Psi(x)$ is used here only as the minimal representation needed to track phase structure. Later sections will introduce additional internal structure, especially torsional topology

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classes, to represent spin. The role of the pair (A, θ) in the present section is therefore restricted: it isolates the mechanism by which charge emerges from phase orientation and stable phase winding.

Second, CUWF distinguishes between arbitrary global rephasing and structural phase orientation. In standard quantum mechanics, an overall global phase often carries no direct observable consequence. CUWF accepts this at the level of many observables, but emphasizes that phase differences, phase gradients, and phase transport around nontrivial topology encode genuine structural information. In A-17, charge will be tied precisely to the orientation of phase transport and to stable winding numbers around topological anchors. For that reason, $\theta(x)$ must be retained as a first-class variable of the construction.

2.2 Entropic Manifold and Stability Constraint

The second ingredient is the CUWF claim that the background is not an inert spacetime stage, but an entropic structure that constrains which field configurations can persist. In CUWF language, the relevant degrees of freedom inhabit an entropic manifold: a space of configurations equipped with stability conditions that penalize incompatible transport of phase and torsion.

For a reader encountering CUWF for the first time, the operational meaning can be stated without invoking the full formalism. CUWF assumes that there exists an entropic functional, that is, a measure of structural cost, which assigns higher cost to configurations with inconsistent or frustrated internal transport, and lower cost to configurations that remain compatible and self-consistent. The dynamics relevant to A-17 may therefore be read not as unconstrained free variation, but as a tendency toward local compatibility under structural constraints.

In this paper, three minimal postulates are sufficient.

(EC1) Local compatibility. The field can be transported locally only if phase structure and torsional structure remain mutually consistent under that transport. When transport around a closed loop fails to return the field to the same structural class, the configuration carries curvature-like content at the effective level.

(EC2) Stability selection. Among the admissible configurations, those that minimize entropic incompatibility are dynamically preferred and therefore persist long enough to be treated as states.

(EC3) Defect tolerance. When global compatibility cannot be maintained, the system localizes incompatibility into discrete sites, namely defects or collapse nodes, thereby producing stable topological anchors rather than diffuse inconsistency.

These postulates provide the minimal reason symmetry appears in CUWF. Symmetries are not imposed as primitive axioms; they arise as the set of transformations that preserve compatibility and therefore do not increase entropic inconsistency. In later sections, U(1) and SU(2) will be shown to emerge as the compatibility-preserving structures associated with phase transport and torsional topology, respectively.

It is equally important to state what is not assumed here. Gauge symmetry is not taken as a foundational postulate. Rather, gauge-like freedom will appear as the mathematical expression of the fact that certain local re-descriptions preserve compatibility while leaving the underlying structural class unchanged.

2.3 Defects or Collapse Nodes as Topological Anchors

A-17 requires a mechanism by which discrete, quantized labels emerge from continuous field variables. In CUWF, that role is played by defects, also described as collapse nodes, which act as topological anchors.

Intuitively, a defect is a localized region in which the ordinarily smooth description of the field becomes singular, multi-valued, or structurally undefined unless an additional topological label is introduced. Defects are not inserted ad hoc. They follow directly from (EC3): when the field cannot maintain global compatibility everywhere, it concentrates incompatibility into discrete locations. This localization allows the remainder of the manifold to remain compatible and therefore stable.

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Defects are indispensable for three reasons that will be used repeatedly throughout the paper.

(D1) Quantization via winding. If $\theta(x)$ is transported around a closed loop encircling a defect, the phase can return to itself only up to an integer multiple of 2π. The associated winding number is therefore an integer topological invariant. In A-17, electric charge will be associated with phase orientation together with such stable winding numbers.

(D2) Conserved classes. Topological invariants cannot change continuously. They change only through nonlocal events such as defect creation, defect annihilation, reconnection, or the crossing of a stability barrier. This is the structural origin of conserved quantities: a conserved charge or spin class is conserved because it is a topological class of the field configuration, not because a conservation law is imposed from outside the system.

(D3) Anchoring internal structure. For spin, the relevant invariants will not be simple phase windings, but torsional topology classes—twist-like or linking-like structures. Defects provide the anchor points around which such torsional classes are defined and stabilized, thereby enabling discrete half-integer behavior to emerge as an effective projection.

A practical way to read the remainder of this paper is therefore the following. The amplitude $A(x)$ controls how strongly a configuration is expressed; the phase $\theta(x)$ carries orientation and supports winding; the entropic manifold supplies the compatibility and stability criterion; and defects or collapse nodes provide the topological anchors that convert continuous variables into discrete, conserved classes. With these preliminaries in place, the paper can proceed to construct charge from phase orientation and spin from torsional topology without treating either as a primitive label.

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