

Section 3. Collapse-Link Topology: The True Structure of Entanglement

If entanglement is defined as entropic synchronization of collapse configurations, then its underlying structure cannot be represented adequately by state vectors, probability amplitudes, or outcome correlations alone. The structure responsible for entanglement must instead be expressed at the level of the relational topology that constrains collapse evolution itself. Within CUWF, this topology is formalized as collapse-link topology.

Collapse links are not dynamical interactions, communication channels, or forces. They are structural constraints that bind collapse configurations into synchronized classes. Entanglement is therefore treated not as a process occurring within spacetime, but as a topological property of the collapse network from which observable correlations later emerge.

3.1 From State Vectors to Explicit Relational Structure

In standard quantum mechanics, entanglement is represented implicitly in Hilbert space through the non-factorizability of joint states:

$$|\Psi\rangle \neq |\psi_1\rangle \otimes |\psi_2\rangle$$

This condition signals entanglement, but it does not yet explain it. The mathematical object encodes correlation, not explicit relational structure. No distinct entity corresponds to what physically links the systems; the relational content remains buried inside algebraic non-separability.

CUWF replaces this implicit encoding with an explicit relational layer. Physical reality is described not as a single global state vector, but as a set of collapse configurations connected by constraint relations. On this view, entanglement corresponds to the existence of nontrivial relational structure prior to projection into outcomes.

State vectors describe what is observed. Collapse links describe what constrains collapse itself.

3.2 Definition of Collapse Links

Let $C = \{C_i\}$ denote the space of collapse configurations, and let $E(C) \subset E_{\text{total}}$ denote the set of entropic constraints acting on configuration C .

A collapse link between configurations C_i and C_j exists if and only if they share nontrivial constraint structure:

$$L_{ij} \neq 0 \iff E(C_i) \cap E(C_j) \neq \emptyset$$

To quantify link intensity, define the constraint-overlap functional:

$$w_{ij} = \int_{E_{\text{total}}} \chi_i(e) \chi_j(e) \rho_E(e) \, de$$

where $\chi_i(e)$ is the indicator function of constraint membership for C_i and $\rho_E(e)$ is the entropic density on constraint space.

In this form, w_{ij} measures how strongly two collapse configurations are forced to co-evolve under shared constraint geometry. Importantly, this quantity is independent of spatial separation, carries no directional information, and cannot be modulated by local operations.

Collapse links therefore encode shared restriction rather than interaction.

3.3 Topological Properties

Collapse-link topology possesses several properties that distinguish it categorically from interaction networks, force graphs, or communication channels.

(i) Non-metricity

There exists no embedding map $d : L_{ij} \rightarrow \mathbb{R}^+$ such that link strength depends on spatial distance.

Collapse-link topology is therefore not a metric graph.

(ii) Pre-spacetime Character

Collapse links are defined entirely on configuration–constraint space. Spacetime coordinates (x, t) appear only after stabilization and projection. Formally:

L_{ij} is defined prior to $\pi : C \rightarrow M_{\text{spacetime}}$

Spatial separation is therefore a derived property rather than an input to the relation.

(iii) Directionlessness

Collapse links do not admit orientation. There exists no ordered pair $(C_i \rightarrow C_j)$, nor any operator $\partial_{i \rightarrow j}$. The topology is undirected and symmetric:

$$L_{ij} = L_{ji}$$

This removes the structural basis for causal interpretation at the link level.

(iv) Persistence Under Projection

Let π_k denote a local measurement projection acting on C_k . Then:

$$L_{ij} \text{ is invariant under } \pi_k \text{ for all } k$$

Collapse links are therefore measurement-invariant structures. Projection may alter local outcome selection, but it does not rewrite the topology that constrains synchronized collapse.

3.4 Entanglement as a Graph-Theoretic Property

The collapse network $G = (C, L)$ may be treated as a graph whose connected components correspond to entangled systems.

Two systems are entangled if and only if their collapse configurations lie in the same connected subgraph:

$$C_i \sim C_j \iff \exists \text{ path } (C_i \leftrightarrow C_j) \text{ in } G$$

Measurement alters local projection within a node, but it does not modify graph connectivity.

Observable correlations therefore reflect traversal of a fixed relational topology rather than transmission across space.

3.5 Why Collapse Links Cannot Carry Signals

A signaling channel would require a controllable mapping of the form:

M : local choice at $C_i \rightarrow$ outcome distribution at C_j

together with modulatability, directionality, and causal dependence.

For collapse links, no such mapping exists. Formally, for all admissible local operations O_j :

$$\partial P(O_j) / \partial O_i = 0 \quad \text{under } L_{ij}$$

This is not an externally imposed prohibition. It follows from the symmetry and non-modulatability of shared constraint overlap. A collapse link provides no encoding degree of freedom, no direction of transfer, and no controllable transmission pathway.

- No encoding.
- No transmission.
- No causal influence.

Signaling is therefore structurally impossible, not merely forbidden by postulate.

3.6 Summary

Collapse-link topology provides the explicit relational substrate missing from correlation-based accounts of entanglement. By elevating entanglement from an algebraic property of states to a topological property of collapse structure, CUWF explains nonlocal correlation without invoking communication, causal transmission, or observer dependence.

Entanglement is not 'spooky action at a distance.' It is shared entropic structure without transmission.