

Section 6 — Formal Structure of Entropic Tunneling in CUWF

Quantum tunneling in CUWF is not treated as a probabilistic jump or as a mysterious penetration through a forbidden region. It is a deterministic restructuring process governed by structural entropy, entropic curvature, and the geometry of the underlying wavefield. This section provides the formal basis for the collapse-node dynamics introduced conceptually in Section 4.

The purpose of the present section is therefore to define the governing variables of tunneling, specify the stability conditions for collapse nodes, formalize the role of barrier-induced entropic distortion, and derive the basic collapse-node mapping that underlies the three-phase tunneling mechanism of CUWF.

6.1 Structural Entropy as the Governing Variable of Tunneling

In CUWF, the particle is not a point-like object moving continuously through space, but a collapse node: a temporary geometric stabilization of the wave that exists only at an entropic minimum. The governing variable of tunneling is therefore not the conventional potential function $V(x)$, but the structural entropy of the composite wavefield.

We define the local structural entropy by

$$S(x) = S[\Psi(x)]$$

where $\Psi(x)$ denotes the composite wave at position x . In the tunneling context, this composite wave may be written schematically as

$$\Psi_{\text{total}}(x) = \Psi_{\text{particle}}(x) + \Psi_{\text{barrier}}(x) + \Psi_{\text{FBW}}(x).$$

Structural entropy characterizes the order, curvature, and local stability of the waveform. Low structural entropy corresponds to an ordered configuration capable of sustaining a collapse node, whereas high structural entropy corresponds to a distorted configuration in which node stability is lost.

A collapse node can exist only at a local entropic minimum satisfying

$$dS/dx = 0, \quad d^2S/dx^2 > 0.$$

Accordingly, tunneling becomes a question of how $S(x)$ evolves across the barrier, where admissible entropic minima exist, and how the wave geometry changes as the system passes through regions of increasing and then decreasing structural entropy.

6.2 Entropic Curvature and Node Stability Conditions

Node stability depends on entropic curvature, which we define in the one-dimensional barrier profile as

$$C_S(x) = d^2S/dx^2.$$

A stable collapse node requires positive entropic curvature in the sense of a local minimum:

$$C_S(x) > 0.$$

A node becomes unstable when the curvature reaches zero or becomes negative:

$$C_S(x) \leq 0.$$

As the incoming wave approaches the barrier, interaction with the barrier wave progressively raises structural entropy and drives the local curvature toward instability. In schematic form,

$$S_{\text{incoming}}(x) \uparrow \Rightarrow C_S(x) \rightarrow 0^-.$$

Within the barrier interior, the curvature becomes negative,

$$C_S(x_{\text{inside}}) < 0,$$

which indicates an entropic maximum rather than an entropic well. Under these conditions node stability is impossible, collapse becomes deterministic, and no stable particle detection can occur inside the barrier region.

6.3 Interaction of Particle Wave and Barrier Wave

The barrier is not treated in CUWF as an abstract potential curve alone, but as a structured wave environment produced by the geometry and dynamics of the material or field configuration that defines the barrier. This includes contributions from atomic lattice structure, electronic configuration, molecular potentials, phonon modes, and electromagnetic boundary conditions.

The incoming particle wave therefore encounters not a static wall, but a structured oscillatory waveform. We write the coupled barrier-region waveform schematically as

$$\Psi_{\text{coupled}}(x) = \Psi_{\text{particle}}(x) \oplus \Psi_{\text{barrier}}(x),$$

where \oplus denotes geometric interference rather than simple linear superposition in the ordinary heuristic sense.

This coupling produces waveform deformation, destructive interference, and a rise in structural entropy. The barrier interior is then characterized by

$$S_{\text{inside}} = S[\Psi_{\text{coupled}}(x)].$$

It is precisely this entropic distortion that generates the local instability responsible for the extinction of Node A.

6.4 Why the Barrier Becomes an Entropic Peak

A barrier emerges when the entropy in the coupled region exceeds that of the pre-barrier region:

$$S_{\text{inside}} > S_{\text{before}}.$$

More importantly, the entropic curvature in the barrier interior becomes negative:

$$C_S(x_{\text{inside}}) = d^2S_{\text{inside}}/dx^2 < 0.$$

This curvature condition signifies that the waveform is maximally distorted, that no admissible local minimum exists there, and that collapse-node stability cannot be maintained. The barrier is therefore identified not with a material obstruction in the classical sense, but with a region of entropic ascent culminating in an entropic peak.

This formal picture immediately explains why tunneling does not involve a particle occupying the middle of the barrier: the wave is present, but the entropic geometry does not permit a stable node to exist there.

6.5 Wave-Only Propagation Through the Entropic Peak

Once Node A collapses, the wave continues without requiring a localized entropic minimum. This reflects a central CUWF principle: wave continuity is unconditional, whereas node continuity is conditional.

Inside the barrier, therefore, the wave persists but the node does not. The barrier suppresses node formation, not wave propagation. In this sense the barrier region is a wave-only domain governed by distorted geometry rather than by particle transport.

This resolves the standard tunneling paradox directly. The particle is not found in the barrier because the collapse node is absent there; the transmission process continues because the underlying wave remains continuous on the Fundamental Wave Basin (FWB).

6.6 Entropic Relaxation Beyond the Barrier and Node B Formation

Outside the barrier, destructive interference relaxes and the composite waveform becomes more ordered. In schematic form,

$$S_{\text{after}} < S_{\text{inside}}.$$

As the local geometry recovers, the entropic curvature becomes positive again:

$$C_S(x_{\text{after}}) > 0.$$

If the post-barrier region contains a new entropic minimum satisfying

$$dS_{\text{after}}/dx = 0, \quad d^2S_{\text{after}}/dx^2 > 0,$$

the wave re-stabilizes into a new collapse node:

$$N_B = \text{collapse at the next entropic minimum.}$$

Node B is not the same particle transported through the barrier. It is the next admissible entropic realization of the same continuous wave. The post-barrier event is therefore a re-instantiation, not a traversal.

6.7 CUWF Collapse Mapping and Effective Node Dynamics

The effective “motion” of a particle in CUWF is not the continuous displacement of a persisting object, but the sequential re-labeling of admissible collapse locations on an evolving entropic landscape.

Let the full entropic field be written as

$$S(x,t) = S[\Psi(x,t)].$$

A collapse node exists only at points satisfying

$$\partial S / \partial x = 0, \quad \partial^2 S / \partial x^2 > 0.$$

We then define the collapse operator C acting on the local wave state as

$$C[\Psi(x,t)] = N(x,t), \quad \text{if } C_S(x,t) > 0$$

$$C[\Psi(x,t)] = \emptyset, \quad \text{if } C_S(x,t) \leq 0.$$

The next admissible collapse location is selected by the post-barrier entropy landscape according to the rule

$$x_{(n+1)} = \arg \min_x S(x, t + \Delta t).$$

The barrier imposes the condition

$$C_S(x_inside) < 0 \Rightarrow N(x_inside) = \emptyset.$$

Accordingly, the formal tunneling sequence is

$$N_A \rightarrow \emptyset \rightarrow N_B,$$

with wave continuity preserved throughout by the underlying FBW. This gives the formal underpinning of the three-phase process presented in Section 4: node destabilization, wave-only propagation, and node re-instantiation.

6.8 Summary

Section 4 has established the formal structure of entropic tunneling in CUWF. Structural entropy replaces the potential function as the governing variable; node stability is defined by entropic minima and positive curvature; barriers correspond to entropic peaks generated by destructive wave interference; and tunneling is formally described as node extinction followed by wave continuity and post-barrier re-instantiation.



The mathematical framework developed here prepares the transition to Section 6, where the entropic geometry of tunneling is expanded in greater detail and connected more explicitly to the global geometric structure of the CUWF wavefield.