Section 4. Collapse Divergence Criteria — When Separation Becomes Permanent

4.1 Collapse Surface as a Topological Object

CUWF defines collapse not as a temporal instant but as a structural region $\Sigma_c \subset \Omega$ in which the accessibility graph $G(\Xi_E)$ changes its topology. Σ_c is the minimal domain of the universal wave field where admissible relational transitions are re-ranked, removed, or newly forbidden due to collapse-induced entropic constraints.

Formally, let $G_X = (V_X, E_X)$ denote the accessibility graph of a stabilized domain-state X, where vertices represent coarse-grained relational states and edges represent closure-preserving admissible transitions. A collapse surface Σ_c is defined as the set of states for which

$$\mathrm{rank}(E_{before}) \neq \mathrm{rank}(E_{after}),$$

i.e., the number of admissible closure-preserving transitions differs across the surface. A collapse event is merely a macroscopic projection of crossing Σ_c; the physical mechanism is the topological deformation of $G(\Xi_E)$ across Σ_c.

4.2 Divergence Threshold and the Origin of Λ_c

Let Ω_1 and Ω_2 be two domain-states emerging on opposite sides of the same collapse surface Σ_c. Define the accessibility gradient as the deformation operator

$$\nabla\Xi_E(\Omega) = \partial G(\Xi_E)/\partial\Sigma_c \ ,$$

which measures how the admissible transition structure changes when crossing Σ_c.

We now define the collapse divergence constant Λ_c as the minimal vertex-cut cardinality **K**(G) of the accessibility graph that preserves closure connectivity:

$$\Lambda_c \equiv \mathbf{K}(G_{pre}),$$

where **K**(G_{pre}) is the vertex-connectivity of the pre-collapse accessibility graph. **K**(G) is the minimal number of vertices whose removal disconnects the graph.

Permanent separation occurs when

$$\| \nabla\Xi_E(\Omega 1) - \nabla\Xi_E(\Omega 2) \| \geq \Lambda_c,$$

meaning that the deformation across Σ_c removes at least **K**(G_{pre}) admissible bridges. At this point the accessibility graph decomposes as

$$G_{pre} \longrightarrow G_{\Omega 1} \sqcup G_{\Omega 2},$$

a disjoint union of closure graphs. This defines the precise structural origin of Λ_c: it is not phenomenological but is inherited from the topological stability of the accessibility network itself.

4.3 Recoverable Divergence vs Structural Rupture

If the deformation across Σ_c removes fewer than **K**(G_{pre}) vertices or edges, i.e.,

$$\| \nabla\Xi_E(\Omega 1) - \nabla\Xi_E(\Omega 2) \| < \Lambda_c,$$

then G(Ξ_E) remains connected. Accessibility bridges still exist, even if they are dynamically suppressed or highly improbable. Such divergence corresponds to decoherence, partial irreversibility, or effective classical branching, but not to parallel universes.

If the deformation equals or exceeds **K**(G_pre), the graph necessarily becomes disconnected by the Menger–Whitney connectivity theorem. No closure-preserving path can connect Ω1 and Ω2. Re-mergeability is not merely unlikely; it is structurally forbidden.

Thus CUWF defines multiverse separation not by probability, decoherence, or observer dependence, but by graph-topological disconnection of the entropic accessibility structure. Parallel universes are born precisely at the moment the accessibility graph crosses its connectivity threshold and fractures into irreducible components.

4.4 The Conceptual Consequence

This criterion provides the missing structural answer to a question left unresolved in both spacetime-based multiverse models and Many-Worlds-style plurality: when does difference become ontological separation? In CUWF, the answer is exact. Difference becomes parallelism only when collapse-induced divergence destroys the closure-preserving connectivity of the accessibility graph. Below that threshold, one still has multiplicity within a single accessible domain. Beyond it, one has structurally disconnected domains within one substrate.

The consequence is decisive. Parallel universes are not defined by probability-weighted alternatives, by unobserved branches, or by observational ignorance. They are defined by irreversible topological rupture in the entropic accessibility structure of the universal wave field. This establishes the formal basis upon which the next section can examine the physical regimes most likely to satisfy such a criterion, especially early cosmological transitions, high-instability collapse regimes, and large-scale entropic bifurcations.

