Section 6. Collapse Directionality: The Core Mechanism

Having clarified what the arrow of time is—and what it is not—we can now turn to the core mechanism responsible for its emergence within the CUWF framework: collapse directionality. The argument of this section is that temporal directionality is not inherited from time itself, not generated by entropy alone, and not imposed from outside through privileged boundary conditions. It arises intrinsically from the structure of collapse as realization.

6.1 Collapse as Realization, Not Evolution

In conventional physical thought, change is almost always framed as evolution: a system evolves from one state to another according to dynamical laws defined over time. CUWF adopts a fundamentally different stance. Collapse is not evolution. It is realization.

A collapse event does not describe a system moving smoothly along a temporal trajectory. Instead, it marks the selection of a definite configuration from a structured space of possibilities. Prior to collapse, multiple configurations may remain available in a non-realized sense. Collapse resolves this indeterminacy by actualizing one outcome.

This distinction may be stated by defining collapse as a realization map:

$$C : \Omega \longrightarrow \mathcal{H}^{R}$$

where Ω denotes the space of possible pre-collapse configurations, $\mathcal{H}^{R}$ denotes the space of realized history states, and C denotes the collapse or realization operator. A specific collapse event then selects a realized history state h_i such that:

$$C(x) = h_i, \quad h_i \in \mathcal{H}^{R}$$

The importance of this formulation is decisive. Evolution presupposes time as a background parameter along which change is tracked. Realization does not. Realization produces definiteness, not

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motion. Once this difference is recognized, the arrow of time can no longer be sought primarily in equations of motion. It must be sought in the structure of the realization map itself.

6.2 Why Collapse Has Intrinsic Direction

Collapse is intrinsically directional because realization is structurally asymmetric. Before collapse, multiple configurations in Ω may remain compatible with the relevant constraints. After collapse, one configuration is realized, while the unrealized alternatives are excluded from the realized history state that now obtains.

This asymmetry is not dynamical in the usual sense. It does not arise because a flowing time parameter pushes the system forward. It arises because the realization map is a one-to-history selection: from a plurality of structurally available possibilities to a definite realized state.

The arrow therefore emerges from the asymmetry between a space of possible configurations and a realized history state. Once realization occurs, the unrealized alternatives do not remain equally available in the same structural sense. They are not simply hidden branches of current access; they are non-realized alternatives excluded by the act of realization itself.

Directionality, in this framework, is thus not added to collapse from outside. It belongs to the logic of selection itself. Collapse is directional because realization is not symmetric between what may be and what has been made definite.

6.3 Why Reverse Collapse Is Structurally Undefined

A natural objection then arises: if collapse is a structural operation, could it in principle be reversed? The CUWF answer is precise. Reverse collapse is not merely difficult or dynamically forbidden. It is structurally undefined.

Formally, although the realization map C is well-defined as

$$C : \Omega \longrightarrow \mathcal{H}^{R}$$

its inverse is not:

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$C^{-1}(h_i)$ is undefined

This is not a statement of technological limitation or incomplete knowledge. It is a structural fact. To reverse collapse would require reconstructing the full space of unrealized alternatives from a single realized outcome. But collapse does not preserve excluded possibilities as recoverable elements of realized history. What was not realized was never written into the realized record-space as an equal member of history.

This is where CUWF differs sharply from the intuition borrowed from time-symmetric evolution. Reverse evolution may be mathematically defined in many dynamical systems. Reverse realization is not. Realization is non-invertible not because it breaks a reversible law by force, but because it is not the kind of operation for which an inverse mapping exists in the first place.

Irreversibility therefore does not arise because collapse violates reversibility. It arises because realization is a structurally non-invertible operation.

6.4 Direction Without Temporal Assumption

Crucially, collapse directionality does not require a pre-existing temporal arrow. The distinction between “before collapse” and “after collapse” need not be interpreted as two positions along a flowing timeline. It may instead be understood structurally: indeterminate versus definite, possible versus realized, unconstrained versus constrained.

This ordering can be expressed without treating time as primitive. Let h_i and h_j be realized history states. Then one may write:

$$h_i \prec h_j \iff h_j \in C(\Omega \mid h_i)$$

That is, a realized history state h_i precedes h_j if h_j is a realization that occurs under constraints already including h_i. The relation is therefore one of ordered historical dependence, not of motion through an independently flowing time-substance.

Under this view, the arrow of time is best understood as a partial order on realized history states rather than as a primitive temporal parameter. Time enters later as an indexing tool used to label this

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sequence of realizations. The traditional hierarchy is therefore inverted. Directionality does not arise because time flows. Time is indexed because collapse produces directional history.

The arrow of time is thus not a fundamental property of time itself. It is the structural signature of collapse directionality projected onto an ordering parameter after realization has already imposed asymmetry upon history.

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