Residue Dynamics and Collapse Channels in the UNNS Substrate:
Sobra, Sobtra, and Operator XII as an Evolution Operator

UNNS Research Program

Abstract

Operator XII is the terminal and generative operator of the UNNS recursive substrate. It receives an arbitrary recursive structure R, extracts its asymptotic echo (sobra), optionally reactivates that echo through torsion (sobtra), and reduces the resulting geometric residue into a new seed from which recursion restarts.

This paper presents:

- the collapse protocol,
- the geometry of pre-collapse shells,
- the formal sobra/sobtra taxonomy,
- curvature propagation and torsion thresholds,
- and the full operator evolution Appendix in UNNS notation.

Operator XII completes the recursive grammar by turning "structure" into "origin" again:

$$R \longrightarrow \text{Residue} \longrightarrow \text{Seed} \longrightarrow R'.$$

Contents

1 Introduction

Within the UNNS substrate, every admissible structure R undergoes iterative echo-damping and geometric contraction until reaching a stable remnant. Operator XII performs the collapse:

$$\text{Structure} \to \text{Echo} \to \text{Seed}.$$

The echo has two canonical forms:

- **SOBRA:** the inert, fully damped, non-propagating remainder.
- **SOBTRA:** the torsion-reactivated, curvature-shifted residue capable of transport.

This distinction determines whether the next recursion is local or transported, analogous in physics to whether a field excitation remains bound or becomes a propagating particle-mode.

2 Collapse Flow Diagram

$$R \xrightarrow{\text{echo extraction}} S_0(R) \xrightarrow{\text{torsion test}} \begin{cases} S_0(R), & \tau(R) \le \delta(R), \\ S_\tau(R), & \tau(R) > \delta(R) \end{cases}$$
$$\xrightarrow{\textbf{XII}} \text{Seed} \xrightarrow{\text{expand}} R'$$

Thus:

$$S_0 = \text{SOBRA}, \qquad S_\tau = \text{SOBTRA}.$$

3 The Residual Echo Operator S_0 (Sobra)

The inert residue is defined by the dissipative limit:

$$S_0(R) = \lim_{k\to\infty} R^{(k)},$$

where $R^{(k)}$ is the k-th echo contraction produced by repeated action of the damping operator $\mathcal{D}$.

The geometry obeys:

$$\Sigma_{k+1} = \mathcal{D}(\Sigma_k), \qquad \text{rad}(\Sigma_{k+1}) < \text{rad}(\Sigma_k).$$

Properties

- **Idempotence:** $S_0(S_0(R)) = S_0(R)$.
- **Collapse invariance:** $\textbf{XII}(R) = \textbf{XII}(S_0(R))$.

- **Geometric meaning:** the curvature-fixed core of the echo tower.

4 The Torsion-Reactivated Operator S_τ (Sobtra)

Torsion reactivation is encoded by:

$$S_\tau(R) = \tau \cdot S_0(R).$$

Geometrically this applies a twist operator $\mathcal{T}_\tau$ to the limit shell Σ_∞:

$$\Sigma_\tau = \mathcal{T}_\tau(\Sigma_\infty).$$

Properties

- **Non-idempotence:** $S_\tau(S_\tau(R)) = \tau^2 S_0(R)$.
- **Transport criterion:** torsion dominates damping.
- **Curvature shift:**

$$H_\tau = H_\infty + \tau h_1, \qquad K_\tau = K_\infty + \tau k_1.$$

5 Collapse Channel Selection

Operator XII chooses the branch:

$$\mathbf{XII}(R) = \begin{cases} \mathrm{Seed}(S_0(R)), & \tau(R) \le \delta(R), \\ \mathrm{Seed}(S_\tau(R)), & \tau(R) > \delta(R). \end{cases}$$

This yields the **Collapse Propagation Theorem**:

$$\tau(R) > \delta(R) \quad \Longleftrightarrow \quad \mathbf{XII}(R) \text{ produces a transported seed.}$$

6 Pre-Collapse Geometry

Let Σ_k be the echo shells with radii r_k:

$$r_k \searrow r_\infty, \qquad S_0(R) = R_\infty.$$

Curvatures converge:

$$H_k \to H_\infty, \qquad K_k \to K_\infty.$$

Sobtra modifies curvature by:

$$\Delta K = K_\tau - K_\infty.$$

Transport occurs when:

$$|\Delta K| > K_{\text{crit}}.$$

7 Restart Logic

Collapse yields a seed σ:

$$R' = \text{Expand}(\sigma).$$

Two modes arise:

- **Local restart:** $\sigma = \text{Seed}(S_0)$ (SOBRA)
- **Transported restart:** $\sigma = \text{Seed}(S_\tau)$ (SOBTRA)

A Appendix A: Operator Evolution in UNNS Notation

A.1 Recursive Field and Projection

Let ψ_R be the structural state associated with recursion R. Define the echo projection operator:

$$\Pi_0 : \psi_R \mapsto \psi_{S_0(R)}.$$

Torsion excitation acts via:

$$\Pi_\tau = e^{\tau T} \Pi_0,$$

where the torsion generator T satisfies $[T, \Pi_0] \neq 0$.

A.2 Collapse as Composite Operator

$$\mathbf{XII} = \mathcal{C} \circ \Pi,$$

where:

$$\Pi = \begin{cases} \Pi_0, & \tau \leq \delta, \\ \Pi_\tau, & \tau > \delta. \end{cases}$$

A.3 Time Evolution $O(t)$

$$O(t) = e^{-t\mathcal{D}} e^{t\tau T}.$$

The long-time limit reconstructs the collapse dichotomy:

$$\lim_{t\to\infty} O(t)\psi_R = \begin{cases} \psi_{S_0(R)}, & \tau \le \delta, \\ \psi_{S_\tau(R)}, & \tau > \delta. \end{cases}$$

A.4 Commutator Structure

$$[\mathcal{D}, T] = \kappa T.$$

Thus:

$$e^{-t\mathcal{D}}\, T\, e^{t\mathcal{D}} = e^{-\kappa t} T.$$

A.5 Seed Geometry

Let σ be the seed extracted by $\mathcal{C}$:

$$\sigma = \begin{cases} \mathcal{C}(\Pi_0 \psi_R), & \tau \le \delta, \\ \mathcal{C}(\Pi_\tau \psi_R), & \tau > \delta. \end{cases}$$

Expansion completes the recursion:

$$R' = \mathcal{E}(\sigma).$$

Acknowledgements

This paper is part of the ongoing UNNS Substrate Program and formalizes residue dynamics, torsion-induced transport, and the evolution logic of Operator XII.