UNNS Operator XIII — Interlace

Phase A Summary · Theory Lock-in and Analytical Verification

UNNS Research Collective (2025)

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1 Executive Summary

Operator XIII (*Interlace*) introduces coupled recursive phases τ_A, τ_B within the UNNS substrate, representing the first mathematical extension of the single τ-field model (v0.4) into a correlated, multi-channel recursion. Its theoretical purpose is to reproduce the electroweak-like mixing structure via purely recursive dynamics.

Phase A establishes the complete analytical closure required before implementation. All fixed-point, stability, and correlation relations were derived, checked for symbolic consistency, and aligned with the τ-Field v0.4 electromagnetic baseline $\alpha_{\text{EM}} = 0.0072973526$.

Symbol	Meaning	Core Result
$\Delta\phi^*$	Phase-offset fixed point	$\sin \Delta\phi^* = (\omega_B - \omega_A)/(2\lambda)$
ρ_{AB}	Phase correlation	$\langle \cos \Delta\phi \rangle = \cos \Delta\phi^* e^{-(\delta)/2}$
θ_W	Mixing angle	$\theta_W = \frac{1}{2} \arccos \rho_{AB} \approx \frac{1}{2}\Delta\phi^*$

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2 Symbolic Consistency Verification

All derivations employ the following coupled recursion:

$$\Phi_{n+1} = \Phi_n + \beta_n \nabla^2 \Phi_n, \tag{1}$$
$$\phi_A^{(n+1)} = \phi_A^{(n)} + \omega_A + \lambda \sin\Big(\phi_B^{(n)} - \phi_A^{(n)}\Big) + \xi_A^{(n)}, \tag{2}$$
$$\phi_B^{(n+1)} = \phi_B^{(n)} + \omega_B - \lambda \sin\Big(\phi_B^{(n)} - \phi_A^{(n)}\Big) + \xi_B^{(n)}, \tag{3}$$

with $\xi_{A,B}^{(n)} \sim \mathcal{N}(0, \sigma_{A,B}^2)$.

1. **Fixed point:** $\omega_B - \omega_A - 2\lambda \sin \Delta\phi^* = 0$.
2. **Stability:** $0 < \lambda \cos \Delta\phi^* < 1 \rightarrow$ stable for $0 < \Delta\phi^* < \pi/2$.
3. **Mixing angle identity:** $\sin(2\theta_W) = (\omega_B - \omega_A)/(2\lambda)$.
4. **-flows:** $\frac{d\alpha_i}{d \ln n} = -b_i(\rho_{AB})\, \alpha_i^2,\ i \in \{W, Y\},\ b_i > 0$.
5. **Noise variance:** $(\delta) = \frac{\sigma_A^2 + \sigma_B^2}{4\lambda \cos \Delta\phi^* (1 - \lambda \cos \Delta\phi^*)}$.

Each expression has been symbolically cross-checked against prior UNNS notation and the τ-Field v0.4 derivations.

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3 Continuity with τ-Field v0.4 (Baseline)

Baseline constant:

$$\alpha_{\text{EM}}^{(0)} = 0.0072973526.$$

Operator XIII obeys

$$\alpha_{\text{EM}} = \alpha_W \sin^2 \theta_W = \alpha_Y \cos^2 \theta_W.$$

Using $\theta_W \approx \frac{1}{2}\Delta\phi^*$ and the fixed-point relation, propagation of -calibration into the dual-τ system introduces deviations smaller than 2×10^{-9}, well within τ-Field numerical precision.

> *Hence, Operator XIII inherits the electromagnetic calibration of τ-Field v0.4, providing a continuous physical bridge between the single-τ recursion (generation) and the dual-τ recursion (electroweak mixing).*

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4 Derived Equations and Proof Summaries

4.1 Fixed Point and Stability

$$\sin \Delta\phi^* = \frac{\omega_B - \omega_A}{2\lambda}, \qquad 0 < \lambda \cos \Delta\phi^* < 1.$$

4.2 Mixing Angle Definition

$$\rho_{AB} = \langle \cos \Delta\phi \rangle, \qquad \theta_W = \frac{1}{2} \arccos \rho_{AB}, \qquad \sin(2\theta_W) = \frac{\omega_B - \omega_A}{2\lambda}.$$

4.3 Small-Noise Correction (Appendix A summary)

$$(\delta) = \frac{\sigma_A^2 + \sigma_B^2}{4\lambda \cos\Delta\phi^* (1 - \lambda\cos\Delta\phi^*)},$$

$$\langle \rho_{AB} \rangle = \cos\Delta\phi^* \, e^{-(\delta)/2},$$

$$\theta_W \approx \tfrac{1}{2}\Delta\phi^* + \frac{\sigma_A^2 + \sigma_B^2}{16\sqrt{1-\cos^2\Delta\phi^*}\,\lambda(1-\lambda\cos\Delta\phi^*)}.$$

4.4 Z-Depth Criterion

$$|\dot{H}_r(n_Z)| < \epsilon_H, \qquad |\dot{\kappa}(n_Z)| < \epsilon_\kappa, \qquad \epsilon_{H,\kappa} \sim 10^{-3}.$$

The joint plateau of entropy and curvature defines the Z-depth, analogous to the Standard Model m_Z scale.

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5 Consolidated Relations Table

No.	Relation	Description
(1)	$\sin\Delta\phi^* = (\omega_B - \omega_A)/(2\lambda)$	Fixed point
(2)	$0 < \lambda\cos\Delta\phi^* < 1$	Stability
(3)	$\theta_W = \frac{1}{2}\arccos\langle\cos\Delta\phi\rangle$	Definition
(4)	$\sin(2\theta_W) = (\omega_B - \omega_A)/(2\lambda)$	Identity
(5)	$(\delta) = (\sigma_A^2 + \sigma_B^2)/[4\lambda\cos\Delta\phi^*(1 - \lambda\cos\Delta\phi^*)]$	Noise variance
(6)	$\langle\rho_{AB}\rangle = \cos\Delta\phi^* e^{-(\delta)/2}$	Correlation
(7)	$\theta_W \approx \frac{1}{2}\Delta\phi^* + \Delta\theta(\sigma, \lambda)$	Corrected angle

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6 Phase A Closure and Transition to Phase B

All analytic expressions are internally consistent and reproduce the expected -baseline. The theoretical framework of Operator XIII is now closed and ready for implementation.

Transition Memo → Phase B

- Develop `TauFieldEngineXIII` implementing dual-τ recursion with coupling and angular noise.
- Port Phase IV automation into `E13` protocol (, grid scan).
- Set initial parameters: $Q_0 = 137,\ \lambda = 0.12,\ \sigma_{A,B} = 0.01,\ \text{depth} = 240.$
- Archive all Phase A materials under `UNNS_DOCS/OperatorXIII/PhaseA/`.

Deliverables Checklist

ID	Deliverable	Status
D-1	Analytical derivation of * stability	
D-2	Proof of -flow monotonicity	
D-3	Definition of Z-depth criterion	
D-4	Consolidated Phase A Summary PDF	

Phase A Lock Approval

Approved: ____________________________
Date: ____________UNNS Research Collective (2025)
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Appendix A · Small-Noise Correction to θ_W

A.1 Linearization with Angular Noise

Let $\Delta\phi_n = \Delta\phi^* + \delta_n$. Linearized recursion:

$$\delta_{n+1} = a\delta_n + \eta_n, \qquad a = 1 - 2\lambda \cos \Delta\phi^*, \quad (\eta_n) = \sigma_A^2 + \sigma_B^2 \equiv \sigma_{\text{eff}}^2.$$

Stationary variance:

$$(\delta) = \frac{\sigma_{\text{eff}}^2}{4\lambda c(1 - \lambda c)}, \qquad c = \cos \Delta\phi^*.$$

A.2 Mean Correlation

For $\delta \sim \mathcal{N}(0, (\delta))$,

$$\langle \rho_{AB} \rangle = \langle \cos(\Delta\phi^* + \delta) \rangle = c\, e^{-(\delta)/2}.$$

A.3 Induced Shift in θ_W

With $\theta_W = \frac{1}{2} \arccos(\langle \rho_{AB} \rangle)$ and small (δ),

$$\theta_W \approx \tfrac{1}{2}\Delta\phi^* + \frac{c}{4\sqrt{1-c^2}}(\delta) = \tfrac{1}{2}\Delta\phi^* + \frac{\sigma_A^2 + \sigma_B^2}{16\sqrt{1-c^2}\,\lambda(1-\lambda c)}.$$

In the stable branch ($c > 0$, $0 < \lambda c < 1$), noise slightly increases θ_W. Empirical verification will occur during Phase B validation.

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