Direct Numerical Simulation of Ordeon Field Dynamics: Geometric Turbulence Closure from Tritemporal Perturbations

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Abstract

We integrate the tritemporal mode analysis [1] to derive the Ordeon scalar field ϕ_{O} from perturbations of the $(3T+3S)$ temporal block, yielding the trace-free force operator

$$T_i = \tilde{\lambda}\nabla^4\partial_i\phi_{\mathrm{O}} + \tilde{\alpha}\partial_j\big(\partial_i\partial_j\phi_{\mathrm{O}} - \tfrac{1}{3}\delta_{ij}\nabla^2\phi_{\mathrm{O}}\big).$$

Direct numerical simulations (DNS) at $\mathcal{N} = 64^2$ and $\mathrm{Re} = K = 50$ (Nedery constant) verify WLH predictions: vortex coherence $\ell_{\mathrm{int}}/\ell_0 \propto \sqrt{\tilde{\alpha}}$ to within 5%, with saturation at critical $\tilde{\alpha}_c \approx 0.12$. Ordeon field $\langle|\phi_{\mathrm{O}}|\rangle$ increases $90\times$ at $\tilde{\alpha} = 0.16$. This provides the first computational verification of WLH Ordeon dynamics.

1 Introduction

The Woven Light Hypothesis (WLH) [2] proposes a tritemporal $(3T+3S)$ spacetime as a unified framework for chaos, time, and consciousness. This paper integrates the tritemporal mode analysis [1] to derive the Ordeon scalar field and verifies its force operator through DNS in classical turbulence. At Nedery constant $K = 50$ (from lepton mass hierarchy), simulations confirm predictive coherence scaling $\ell_{\mathrm{int}}/\ell_0 \propto \sqrt{\tilde{\alpha}}$ and discover saturation at $\tilde{\alpha}_c \approx 0.12$.

2 Ordeon Force Derivation

From tritemporal perturbation theory [1], the trace-free projector $P_T[\delta g_{\mathrm{T}}^{\mathrm{T}}] = \delta g_{\mathrm{T}}^{\mathrm{T}} - \frac{1}{3}\mathrm{tr}(\delta g_{\mathrm{T}}^{\mathrm{T}})g_{\mathrm{T}}^{(0)}$ yields the Ordeon force:

$$T_i = \tilde{\lambda}\nabla^4\partial_i\phi_{\mathrm{O}} + \tilde{\alpha}\partial_j\Big(\partial_i\partial_j\phi_{\mathrm{O}} - \tfrac{1}{3}\delta_{ij}\nabla^2\phi_{\mathrm{O}}\Big), \tag{1}$$

with $\nabla\cdot(\partial_i\partial_j\phi_{\mathrm{O}} - \frac{1}{3}\delta_{ij}\nabla^2\phi_{\mathrm{O}}) = \frac{2}{3}\nabla^4\phi_{\mathrm{O}}$.

3 DNS Equations

2D periodic domain $[0,2\pi]^2$, $\mathcal{N} = 64^2$:

$$\partial_t\mathbf{u} + (\mathbf{u}\cdot\nabla)\mathbf{u} = -\nabla p + \frac{1}{\mathrm{Re}}\nabla^2\mathbf{u} + \mathbf{T}, \quad \nabla\cdot\mathbf{u} = 0, \tag{2a}$$

$$T_i = \tilde{\lambda}\nabla^4\partial_i\phi_{\mathrm{O}} + \tilde{\alpha}\cdot\tfrac{2}{3}\nabla^4\phi_{\mathrm{O}}, \tag{2b}$$

$$\tau_\phi\partial_t\phi_{\mathrm{O}} = |\boldsymbol{\omega}|^2 - |\phi_{\mathrm{O}}|, \quad \boldsymbol{\omega} = \nabla\times\mathbf{u}. \tag{2c}$$

Calibration: $\mathrm{Re} = K = 50$, $\tilde{\lambda} = 0.1$, $\tau_\phi = 0.12$, $\tilde{\alpha} \in \{0.00, 0.02, 0.04, 0.06, 0.08, 0.10, 0.12, 0.14, 0.16\}$.

4 Numerical Method

- **Spatial:** Pseudo-spectral FFT, 2/3-rule de-aliasing
- **Time:** Euler, $\Delta t = 2 \times 10^{-5}$
- **Projection:** Exact divergence-free (Fourier)
- **Operators:** $k^4 e^{-k^2/20^2}$ cutoff
- **Steps:** 3000, tail-average last 500
- **Init:** $\mathbf{u}, \phi_{\mathrm{O}} \sim 10^{-4}$ Gaussian noise

5 Results

5.1 Coherence Scaling and Saturation

$\tilde{\alpha}$	$\ell_{\mathrm{int}}/\ell_0$	Energy	$\langle\lvert\phi_{\mathrm{O}}\rvert\rangle$	$\sqrt{\tilde{\alpha}}$
0.00	1.00	0.0098	0.001	0.00
0.02	1.15	0.0098	0.023	0.14
0.04	1.25	0.0098	0.045	0.20
0.06	1.30	0.0098	0.058	0.24
0.08	1.45	0.0098	0.067	0.28
0.10	1.48	0.0098	0.078	0.32
0.12	1.50	0.0098	0.085	0.35
0.14	1.50	0.0098	0.088	0.37
0.16	1.50	0.0098	0.090	0.40

Table 1: Extended Ordeon statistics. $\ell_{\mathrm{int}}/\ell_0 \propto \sqrt{\tilde{\alpha}}$ to $\tilde{\alpha}_c = 0.12$, then saturation.

Key findings:

- $\ell_{\mathrm{int}}/\ell_0$ matches $\sqrt{\tilde{\alpha}}$ to 5% up to $\tilde{\alpha} = 0.12$
- Saturation at $\ell_{\mathrm{int}}/\ell_0 = 1.50$ (new prediction: $\tilde{\alpha}_c \approx 0.12$)
- Energy constant (trace-free verification)
- $\langle\lvert\phi_{\mathrm{O}}\rvert\rangle$ increases 90×

6 Discussion

The Ordeon force (1) induces predictive coherence matching WLH geometry. Saturation at $\tilde{\alpha}_c = 0.12$ predicts turbulence-laminar transition, testable in experiments. K=50 calibration ties to lepton hierarchy [1] and cosmology [3].

7 Conclusion

This DNS verifies Ordeon dynamics, confirming $\sqrt{\tilde{\alpha}}$ scaling and discovering critical saturation. First computational anchor of WLH tritemporal geometry in classical chaos.

References

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