GIE-Soliton Monitor: An Algorithmic Framework for Detecting Pricing Singularities

Engineering Implementation for the 5061.19 Physical Benchmark

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Abstract

Abstract: Following the theoretical establishment of the 5061.19 pricing singularity [Ma, 2026], this technical report operationalizes the GIE dynamics into a deployable quantitative system. We introduce a complete 8-equation framework combining H_∞ **filtering** and **Lévy Flights** for signal extraction, **Symplectic Integrators** for soliton capture, and **Landau-Ginzburg potentials** for phase transition detection. This document serves as the SOP for identifying "Dimensional Transitions".

1 Introduction

While our previous work established the physical legitimacy of the 5061.19 singularity, the current financial engineering toolkit lacks instruments to monitor such non-linear phenomena. This report bridges the gap by providing the "Fire Control Radar" for the GIE theory.

2 Signal Processing Layer

2.1 Robust H_∞ Filter

To extract the pure Geopolitical (G) factor from non-Gaussian noise, we employ the Minimax criterion. This ensures robust tracking even under extreme volatility:

$$\min_{\hat{x}} \max_{w,v} \frac{\int_0^T ||z - H\hat{x}||^2 dt}{\int_0^T (||w||^2 + ||v||^2) dt} < \gamma_{perf}^2 \tag{1}$$

2.2 Lévy Flight Characteristic Function

We model the market noise not as Brownian motion, but as Lévy flights with infinite variance. The G-field intensity is verified by the fractional derivative index α:

$$G_{field} = \oint_{\Gamma} e^{-itx} \cdot \exp\left(-\gamma |t|^{\alpha} [1 - i\beta \mathrm{sgn}(t) \Phi(t, \alpha)]\right) dt \tag{2}$$

2.3 Expectation Dynamics

The acceleration of expectation follows a trajectory on a curved manifold, described by the Lie Bracket operator:

$$\frac{D}{dt}(\mathrm{Ad}_g \cdot \xi) = [\xi, \eta] + \nabla_{\dot{\gamma}} \xi \tag{3}$$

3 Singularity Solution Layer

3.1 Symplectic Integrator for Solitons

To maintain energy conservation during the simulation of the 5061.19 steady state, we utilize a symplectic structure preserving the Hamiltonian $\mathcal{H}$:

$$P_t = J \cdot \frac{\delta \mathcal{H}}{\delta P}, \quad \text{where } J = \frac{\partial}{\partial x} \tag{4}$$

3.2 Inverse Scattering Transform (IST)

The spectral signature is locked via the Lax pair eigenvalue problem:

$$\hat{L}\psi = \lambda \psi, \quad \text{with } \hat{L} = -\frac{\partial^2}{\partial x^2} - u(x, t) \tag{5}$$

4 Phase Transition and Warning

4.1 Landau-Ginzburg Free Energy

The system enters a phase transition when the Gamma order parameter breaks the symmetry of the Free Energy potential well:

$$F[\Gamma] = \int \left(\frac{1}{2}|\nabla\Gamma|^2 + \frac{r}{2}\Gamma^2 + \frac{u}{4}\Gamma^4 - H_{ext} \cdot \Gamma \right) d^d x \tag{6}$$

4.2 Renormalization Group Flow

The criticality of Gamma drift is verified by the Beta function flow, detecting the loss of scale invariance:

$$\left(\mu \frac{\partial}{\partial \mu} + \beta(g) \frac{\partial}{\partial g} + \gamma_\Gamma \right) \Gamma^{(n)} = 0 \tag{7}$$

4.3 Catastrophe Bifurcation Set

The collapse point corresponds to the singularity in the Cusp Catastrophe manifold, defined by the bifurcation set:

$$27G^2 + 4E^3 = 0 \tag{8}$$

4.4 Psi (Ψ) Collapse Alarm

The ultimate system crash warning is governed by the energy depletion ratio. The implementation logic is as follows:

Listing 1: Psi Index Calculation Kernel

```
import numpy as np

def calculate_psi_warning(dE_dt, dG_dt, G_val, kappa=0.05):
    """
    Psi Index: Expectation Velocity / Damping Field.
    """
    # Damping Field (Denominator)
    # The equals sign and asterisk WILL be visible now.
    damping_field = np.abs(dG_dt) + kappa * G_val

    # Check for vacuum state (Singularity Risk)
    if damping_field < 1e-6:
        return 999.9 # Super-Critical Collapse

    # Calculation Logic
    psi = np.abs(dE_dt) / damping_field
    return psi

# Real-time Monitor Loop
current_psi = calculate_psi_warning(15.62, 0.0, 43.72)

if current_psi > 2.5:
    print(">>> ALERT: Dimensional Collapse Imminent!")
```

5 Conclusion

This framework operationalizes the GIE theory into a deployable quantitative strategy. By monitoring the Ψ index, market participants can navigate the post-5061.19 era with algorithmic precision.

References

[1] Ma, Raymond. (2026). *The 5061.19 Singularity: Physical Benchmarking in Post-Credit Markets*. Zenodo. **DOI: 10.5281/zenodo.18631008**