Swirl–String Theory: Canon v0.4

A Formal Axiomatic Framework

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Abstract

We present Canon v0.4 of the Swirl–String Theory (SST), formally recast in Euclidean structure using axioms, definitions, lemmas, and theorems. Chirality and wave–particle duality emerge as consequences of the topology and dynamics of quantized circulation structures in a swirl field medium. We include structural diagrams and identify conjectural/empirical components separately in an appendix.

Contents

1 Axioms

[Swirl Flux Quantization] The total swirl flux through any closed 2-surface A is quantized:

$$\Phi_{\text{sw}} = \int_A \boldsymbol{\rho}_{\text{sw}} \cdot d\boldsymbol{A} = N\kappa, \quad N \in \mathbb{Z}.$$

[Chronos–Kelvin Invariant] For any swirl flow on a time foliation leaf Σ_t, the following invariant holds:

$$\frac{D}{Dt}(R^2\omega) = 0.$$

[Quantized Circulation] Each swirl loop carries quantized circulation:

$$\Gamma_n = n\frac{h}{m_e}, \quad n \in \mathbb{Z}.$$

2 Definitions

[Swirl Clock] The Swirl Clock $S_t^{\circlearrowleft}$ (or $S_t^{\circlearrowright}$) is the local time rate determined by swirl velocity orientation and magnitude, given by

$$dt_{\text{local}} = dt_\infty \sqrt{1 - \frac{|\boldsymbol{v}_{\circlearrowleft}|^2}{c^2}}.$$

[Ring Phase R] The R phase is a delocalized toroidal (unknotted) swirl-string with persistent circulation. It supports interference phenomena and corresponds to wave-like behavior.

[Knot Phase T] The T phase is a localized, knotted string with positive curvature and topological helicity. It corresponds to particle-like, countable phenomena.

[Vortex Core Radius r_c] The minimal radial scale below which swirl structures collapse into discrete quantized cores.

3 Lemmas and Theorems

[de Broglie Wavelength from Swirl Quantization] For a ring phase of radius R, the wavelength is given by:

$$\lambda = \frac{2\pi R}{n}, \quad \text{with } \Gamma_n = n\frac{h}{m_e}.$$

[R–T Transition by Photon Resonance] Let an R-phase swirl-string be exposed to a photon of energy $\hbar\omega$. The system transitions to a T-phase if:

$$\hbar\omega \geq \Delta E_{\text{eff}}[K],$$

where K is the minimal knot state.

[Vortex Nucleation Threshold] Given compressive swirl flux with spacing a, vortex lines must nucleate when:

$$a \lesssim \alpha r_c,$$

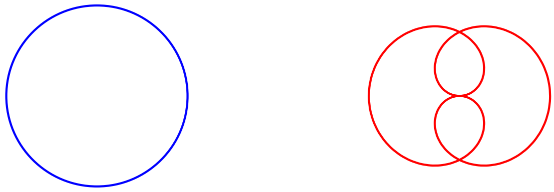
where α is a geometry-dependent constant.

[Fringe Visibility Decay] If Γ is the knotting rate under EM interaction, interference visibility decays as:

$$V(\Gamma, \tau) = e^{-\Gamma\tau}.$$

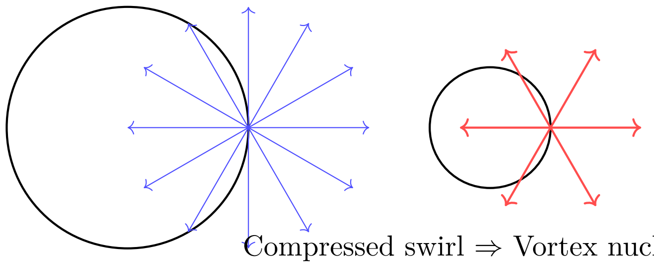
4 Illustrative Diagrams

Figure 1: Ring vs. Knot Phase Representation



Ring Phase R Knot Phase T

Figure 2: Swirl Flux Compression and Vortex Nucleation



Compressed swirl $\Rightarrow$ Vortex nucleation

5 Conjectures and Empirical Appendix

- **Conjecture 1 (Dynamic Chirality):** Time-asymmetric photoionization delays result from Swirl Clock orientation.
- **Conjecture 2 (Topological Memory):** Knot phase T retains initial swirl orientation beyond ionization.
- **Empirical Mapping:** Han et al. (2025) report $\Delta\tau = 60$–240 as; mapped via $\Delta\ell = v_e \cdot \Delta\tau$ to 0.5–4.5 Å path differences.