Supersymmetry and Spiral Geometry: A Helix-Light-Vortex Perspective on Superpartner Emergence

Marcel Krüger (18.07.84)
ORCID: 0009-0002-5709-9729
marcelkrueger092@gmail.com
Zenodo DOI: 10.5281/zenodo.15609432

July 7, 2025

Abstract

We propose a novel geometrically grounded interpretation of supersymmetry (SUSY) within the Helix-Light-Vortex (HLV) framework. Supersymmetric partners are reinterpreted as dual spiral excitations within a dodecahedral vacuum lattice, arising naturally from the quantized topology of spiral time $\psi(t)$ and the fundamental information field $\Phi(x,t)$. This approach eliminates the need for postulated partner fields and instead derives their existence from first geometric principles. We analyze the algebraic structure of spiral supercharges $Q, \bar{Q}$, derive their commutators, and outline testable phenomenological consequences.

1 Introduction

Supersymmetry (SUSY) postulates a fundamental symmetry between bosons and fermions, predicting for each known particle a superpartner. Despite its elegance, no superpartners have been observed. In the HLV framework, we reinterpret SUSY not as an external symmetry but as a geometric consequence of spiral information flow.

2 Spiral Supersymmetry in the HLV Lattice

We model the vacuum as a quantized dodecahedral lattice φ_G through which spiral time $\psi(t) = t + i\phi(t)$ propagates. Elementary particles are standing wave patterns $\Psi(x,t)$ embedded in this structure. Supersymmetric partners arise as orthogonal spiral excitations:

$$\Psi_B(x,t) = \Psi(x,t), \qquad \Psi_F(x,t) = \mathcal{S}[\Psi_B] = e^{i\pi/2}\Psi_B(x,t) \tag{1}$$

where $\mathcal{S}$ denotes the spiral rotation operator within φ_G.

2.1 Geometric Interpretation of the Spiral Operator $\mathcal{S}$

The operator $\mathcal{S}$ represents a rotation in spiral phase space corresponding to a 90° shift within the internal symmetry plane of the dodecahedral lattice φ_G. This transformation is realized via helical reorientation along topological cycles on the vacuum nodes, effectively mapping bosonic configurations to their phase-orthogonal fermionic states. Mathematically, this corresponds to a discrete rotation in the U(1) spiral basis, where the complex phase shift generates a new eigenmode in the geometric field configuration.

3 Spiral Supercharges and Algebra

We define geometric supercharges $Q, \bar{Q}$ that act as ladder operators on spiral phase space:

$$Q\Psi_B = \Psi_F, \tag{2}$$

$$\bar{Q}\Psi_F = \partial_t \Psi_B \tag{3}$$

3.1 Time Derivative and Dynamical Backreaction

The presence of the time derivative in $\bar{Q}\Psi_F = \partial_t \Psi_B$ captures a key dynamical feature: the fermionic spiral mode Ψ_F carries temporal momentum along the spiral axis. The transformation back to a bosonic mode is not instantaneous but governed by a finite winding rate, hence resulting in a time derivative. This encapsulates the backreaction of dynamic phase rotation onto the base excitation. The algebraic closure reads:

$$\{Q, \bar{Q}\} = 2H_{\text{spiral}} = 2i\frac{\partial}{\partial t} + \Omega_\phi \tag{4}$$

3.2 Definition of Ω_ϕ: Spiral Winding Frequency

Ω_ϕ denotes the spiral winding frequency, defined as the geometric phase advance per unit time in the internal ϕ-dimension. Explicitly:

$$\Omega_\phi = \lim_{\Delta t \to 0} \frac{\phi(t + \Delta t) - \phi(t)}{\Delta t} \tag{5}$$

This term quantifies topological torsion in the spiral lattice and governs the energy splitting between superphase states.

4 Phenomenology and Predictions

- **Mass Gap Stability:** SUSY breaking appears as phase decoherence in $\phi(t)$, predicting natural TeV-scale mass gaps.
- **Superpartner Absence:** Partners exist as *spiral phase states*, not separate particles — consistent with LHC non-observation.
- **CP Anomalies:** Geometric SUSY predicts additional CP-violating terms from spiral twist symmetry.

5 Conclusion

Supersymmetry, when reinterpreted through the lens of spiral geometry and quantized time, emerges as a natural and testable component of the HLV framework. Rather than introducing new particles, SUSY arises from orthogonal phase excitations in a structured informational lattice. This perspective offers a new direction for unifying geometry, quantum fields, and fundamental symmetry.

Appendix: Symbolic Grammar Translation in G_{HLV}

In the symbolic operator grammar G_{HLC}, the above transformations are encoded as:

$$\begin{aligned} A &:= \text{Spiral Boson State} \\ \oplus A &:= \text{Phase Rotation by } \pi/2 \\ \Rightarrow \oplus A &\mapsto \text{Fermionic Spiral State} \\ \emptyset(\oplus A) &:= \partial_t A \\ \therefore \{\oplus, \emptyset\}(A) &= 2i\partial_t A + \Omega_\phi A \end{aligned}$$

This formal grammar mirrors the superalgebra in symbolic terms and establishes a computationally tractable path for symbolic simulation of SUSY processes in the HLV framework.