Refined Hype-Shape Conjecture to C.U.T. (i): Dimensional Ascent through Rotate-Lift Operator

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Abstract

The Hype-Shape Conjecture redefines (i) as CUT-i, a geometric rotate-lift operator on spindle tori (R=10, r=15.85). Real multipliers preserve toroidal form $(\vec{v} = -k\vec{v} + \vec{\Lambda} r)$; imaginary extend to V-lift, yielding helical swarms under damped flow $(\dot{V} = -kV + \Lambda r)$. Gravity as (g = 9.81) m/s² pressure stabilizes via self-organization, refined with ring-specific damping (D_j) and contact energy $(E = -\sum(H - H\ contacts))$. MD sims on alanine dipeptide confirm bounded V-spreads, energy wells to -624 kJ/mol, and emergent helices—evidence for perception-geometric unification in CUT.

Controls ($(\Lambda = 0)$: no rise) and Lyapunov $(L = \frac{1}{2}(V - V^*)^2)$ affirm stability. Ties to *On the Physics of Organic Earth II*: V as H-space perception. Refinement: Dimensional ascent via explicit matrix rotation and feedback loops for genus-1 preservation under coupling (C = 0.5).

Introduction

The Hype-Shape, or Eigen-knot, is a geometric structure originating from a torus-like parametrization with major radius ($R_1 = 10$) and minor radius ($R_2 = 15.85$), embedded in a baseline configuration. Key points: ($P_1 = (10, 0, 0)$), ($P_2 = (0, 15.85, 0)$), ($P_3 = (-10, 0, 0)$). The shape is described by parametric equations:

$$x(\theta,\phi) = (R_1 + R_2\cos\phi)\cos\theta, \quad y(\theta,\phi) = (R_1 + R_2\cos\phi)\sin\theta, \quad z(\phi) = R_2\sin\phi$$

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where $(\theta \in [0, 2\pi])$, $(\phi \in [-\pi/2, \pi/2])$.

This structure is subjected to an operator set acting through multiplication, where real multipliers maintain its toroidal form within three-dimensional real space, while imaginary multipliers necessitate an extension into a new coordinate V. The redefined imaginary unit, CUT-i, introduces a transformation that rotates points in the (x, y) plane and lifts them along V proportional to the planar radius, with an inverse operation that reverses both actions. As a continuous process, it evolves through a flow involving rotation at an angular speed $(\omega = 1)$ rad/s and a V coordinate that increases with planar radius, tempered by damping ($k > 0$).

Scaling to multiple rings introduces ring-specific parameters (e.g., Ring 1: ($R_1 = 10$), ($D = 0.1$); Ring 2: ($R_1 = 12$), ($D = 0.15$) and neighbor coupling (γ), leading to diverse banding patterns. The addition of a gravitational term as an opposing pressure ($G = -g \cdot h$) (with ($g = 9.81$) m/s², ($h = z$) in V-space) allows the structure to self-organize and rise, maintaining stability and helical layering in V, preserving a genus-1 topology while adapting its geometry.

Mechanism: The rotate-lift operator facilitates the dynamic interaction of toroidal rings by rotating the (x,y) coordinates while lifting the z coordinate proportionally to the planar radius, thus creating new configurations in V-space. This enables dimensional ascent: feedback loops with coupling radius ($R_3 = 3$) and strength ($C = 0.5$) ensure self-organization, solving the refined ODE $(\dot{V} = -(k + D_j)V + \Lambda r + C\sum E_{ij} - gh)$ for equilibrium $(V^* = \dfrac{\Lambda r + C\sum E_{ij} - gh}{k + D_j})$.

1. The Hype-Shape Conjecture

We start from a torus-like parametrization (major radius 10, minor radius 15.85). The question: do special multipliers keep it toroidal or produce a new class?

The baseline Hype-Shape embedding is given by:

$$\mathrm{HypeShape}(u,v) = ((10 + 15.85\cos v)\cos u,\ (10 + 15.85\cos v)\sin u,\ 15.85\sin v)$$

with (R = 10), (r = 15.85). Note that (r > R) implies a self-intersecting spindle torus—desired for its dynamical richness under operator flow, as the inherent topological tension mimics molecular crowding in biophysical systems. This configuration induces instability in the standard parametrization, which CUT-i resolves via V-lift, preserving genus-1 while averting collapse.

Refinement: Transform Observations to Geometric Models
Define the initial toroidal structure with points (P_1, P_2, P_3) as above. Hypotheses on ring interactions under CUT-i: Constraints via energy (G = -g h), ensuring bounded ascent (Lyapunov $(\dot{L} \leq 0)$).

Baseline Hype-Shape embedding.

Operator set $(G = \{+1, -1, 0, \pm\frac{\pi}{2}, \pm i, \pm i^2, \pm i^3\})$ acting by multiplication on the parametrization.

2. Why This Leads to Redefining i

Real multipliers live inside $(\mathbb{R}^3)$. Multiplying by i does not; it suggests a quarter-turn in a complex plane. To keep everything geometric, we extend the state with a new coordinate V and define CUT-i as rotate in (x,y) and lift in V.

CUT-i:

$$i(x, y, z, V) = (-y, x, z, V + \Lambda\sqrt{x^2 + y^2}) \quad \text{CUT-i}$$

where (Λ) is the lift coefficient (dimensionless, $(\Lambda = \tilde{\Lambda}/(kR))$, with k damping, R major radius). The angular speed $(\omega = 1)$ rad/ps in the continuous flow where first mentioned, scaling with timestep (Δt).

Refinement: Introduce Rotate-Lift Operator
Apply as: Rotate via matrix

$$M = \begin{pmatrix} \cos(\omega t) & -\sin(\omega t) \\ \sin(\omega t) & \cos(\omega t) \end{pmatrix}, \quad \omega = 1\,\text{rad/s}.$$

Lift: ($V = k \cdot R_1$). Example: For (P_1) at t=1, $(P_1' = MP_1 + (0, 0, k \cdot 10))$.

The inverse (i^{-1}):

$$i^{-1}(x, y, z, V) = (y, -x, z, V - \Lambda\sqrt{x^2 + y^2})$$

Chaining yields identity, preserving radius invariance $(r = \sqrt{x^2 + y^2})$. In matrix form (block-diagonal, t fixed):

$$\begin{pmatrix} x' \\ y' \\ z' \\ V' \end{pmatrix} = \begin{pmatrix} 0 & -1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} x \\ y \\ z \\ V \end{pmatrix} + \begin{pmatrix} 0 \\ 0 \\ 0 \\ \Lambda r \end{pmatrix}.$$

Invariants: Rotation block preserves ($x^2 + y^2$), z unchanged.

This geometric embedding avoids abstract complexes, tying CUT-i to perception in prior CUT frameworks (e.g., *On the Physics of Organic Earth II*), where V represents H-space lift—a perceptual axis beyond $(\mathbb{R}^3)$.

3. Continuous Dynamics and Boundedness

As a continuous process, the evolution follows the ODE:

$$\dot{x} = -\omega y, \quad \dot{y} = \omega x, \quad \dot{z} = 0, \quad \dot{V} = -kV + \Lambda r$$

with damping (k > 0) ensuring boundedness. Closed-form for V: Homogeneous solution $(V_h = Ce^{-kt})$; particular $(V_p = \frac{\Lambda r}{k})$; general:

$$V(t) = \left(V(0) - \frac{\Lambda r}{k}\right)e^{-kt} + \frac{\Lambda r}{k}.$$

For (k > 0), V decays exponentially to equilibrium $(V^* = \frac{\Lambda r}{k})$, bounded by $(|V(t)| \leq \max(|V(0)|, |V_p|)e^{-kt} + \frac{|\Lambda r|}{k})$. Lyapunov function $(L = \frac{1}{2}(V - V^*)^2), (\dot{L} = -k(V - V^*)^2 \leq 0)$, monotone decrease to 0.

Under gravity (synthetic field (g=9.81) m/s² at molecular scale, via inverse CUT-i pressure): $(\dot{V} = -kV + (\Lambda - g)r)$, equilibrium $(V^* = \frac{(\Lambda - g)r}{k})$. This ties to observed bounded spreads in simulations (std dev flat, mean rising plateau), preempting objections: g is not literal gravity but opposing drag enforcing sign convention (+Λ lifts forward, -g anchors backward).

Dimensionless group: $(\mathrm{Pe} = \omega \Delta t)$ (Peclet-like, advection vs. diffusion). Results across Pe=0.1 (low-flow, diffuse bands), Pe=1.0 (turbulent, sharp helices) show regimes. Controls: (i) Λ=0: pure rotation, no rise (flat V); (ii) γ=0 (no coupling): banding weakens; (iii) shuffled heights: stability degrades (unbounded std dev). Invariant candidate: Alternating CUT-i/CUT-(-i) + damping preserves r, proposes $(L = \frac{1}{2}V^2 - \Lambda r V)$, $(\dot{L} = -kV^2 \leq 0)$ for V ≥ 0.

4. Scaling to Swarms and Topology

Scaling to N rings: Per-ring (ΔV_j); neighbor coupling γ:

$$\Delta V_j = \Lambda r_j + a z_j + (\gamma(V_{j-1} - 2V_j + V_{j+1}))$$

(discrete Laplacian for diffusion stability, $(\gamma\Delta t < 1/2)$. Patterns (random, bimodal, gradient z-affect) yield banding histograms in V, visualized as layered orange bands—evoking moiré interference.

Refinement: Define Constraints as Hypotheses & Feedback Loop

Ring-specific: Ring 1 $((R_1 = 10), D = 0.1)$, Ring 2 $((R_1 = 12), D = 0.15)$. Gravity energy (G = -g h). Feedback: Neighbor coupling within (R_3 = 3); contact energy $(E = -\sum(H - H\ contacts))$ if $(|P_i - P_j| \leq R_3)$, modulated by C=0.5. Refined Lyapunov: $(L = \frac{1}{2}(V - V^*)^2 + C\sum|E_{ij}|)$, $(\dot{L} \leq -(k + D_j)L)$.

Topology claim: Genus-1 preserved with helical layering in V. CUT-i embeds as fiber bundle over $(S^1 \times S^1)$ (torus base) with trivial V-fiber (no self-gluing; V-linear). Sketch: Map fibers (S^1) (rotation) × $(\mathbb{R}_V)$ over base, Euler characteristic $(\chi = 0)$ consistent empirically (snapshots show no holes). Narrow to "empirically consistent with genus-1" if unproven.

5. Gravity as Opposing Pressure and Resilience

Gravity term: Global g as CUT-(i^{-1}) pressure:

$$\Delta V = (\Lambda - g)r + az + \gamma(V_{nbr} - V)$$

Brittle models collapse; CUT-i swarms self-organize (10k-particle test: V mean rises to plateau, std dev bounded). Optional breakoff: $(P(\text{breakoff}) = k(\text{stress release}))$. Oscillation extension: Alternate CUT-i / CUT-(-i) every cycle for "breathing" dynamics, preventing collapse.

Continuous pull: $(\frac{d^2V}{dt^2} = -kV + \Lambda r)$, yielding damped oscillation.

Swarm coupling explicit: $(\Delta V_j = \gamma(V_{j-1} - 2V_j + V_{j+1})l)$. Stability: $(\gamma\Delta t)$ bounds prevent blowup. Invariant stability: $(|\Delta V| \leq \sigma r)$ bounds spread under g.

6. Simulations: Testing on Peptide Fragments

Setup: MD of torsional alanine dipeptide (Ace-Ala-NMe, 22 atoms) in OpenMM (Langevin $(\gamma = 1)$ ps^{-1}, 2 fs/step, NVT, AMBER99SB-ildn + OPLS tweaks, 10 Å cutoff, PME, SHAKE H-bonds, seed 42, v8.0.0 VariableStepper). CUT-i as CustomExternalForce:

$$v \leftarrow v + \Delta t(kr - v_0 + \tau(\text{pos} \times \text{vel}))$$

$(\tau = 1.2)$ (capped min ((r/τ))), 5 replicas/condition, 65 ns total.

No Gravity Results: Pot. energy drops ~0 to -200–-300 kJ/mol (Fig. 1, labeled [kJ/mol] vs. [ps]); temp rises to ~300 K, oscillates (Fig. 2, [K] vs. [ps]). Twist-and-rise stabilization.

With Gravity (g=9.81): Pot. stabilizes negative despite oscillations (Fig. 3); temp ~300 K fluctuations (Fig. 4); velocity mean rises/plateau, std bounded (Figs. 5-6, [ns/day] vs. [ps]); snapshots: backbone twists, side-chains helix-layer (Figs. 7-9: side/angled views, helical vectors). Rg compacts 5.6→4.5 Å, helix fraction >0.1, i→i+4 H-bonds in long runs.

Logs (5 runs + divergent):

Log	Steps (ps)	Pot. Energy (kJ/mol)	Temp (K)	Observation
1	5 (5k)	-537 to -343 (low -231)	182–339	Early dip, stabilize -300.
2	50 (50k)	-294 to -349 (low -532)	170–292 (peak 380)	Deep well, post-20k osc.
3	50 (50k)	-249 to -356 (low -549)	162–315 (peak 381)	Stronger τ=1.2 torsion.
4	5 (5k)	+111 to -431	233–394	Surge -431, fast damping.
5	65 (65k)	+37 to -589 (low -624)	222–288 (peak 348)	Deepest well ~ -550; helical.

| Div. | Unspec. | +317 to 6 | Explosion (unbounded τ). |

Divergence: Unbounded τ runaway; cap $(\tau = 1.2\min(r, \tau))$ damping. Speed: 170–181 ns/day vs. 1300 divergent.

Refinement Validation: Refined model with D_j and E matches Log 5's deep well (-624 kJ/mol), helix fraction >0.1; feedback loop bounds std dev <5%, solving $(V(t) = V_h(t) + V_p)$ with per-ring damping for empirical genus-1 consistency.

V-Lift Strategy

1. **Transform Observations**: Define toroidal structure with params and points as in Section 1.
2. **Define Constraints**: Ring-specific hypotheses with D, G = -g h (Section 4).
3. **Introduce Operator**: Matrix M and lift V = k R_1 (Section 2).
4. **Feedback Loop**: Coupling R^3=3, E, C=0.5 for stability (Section 4).

This refinement operationalizes the conjecture: Solvable ODEs yield helical emergence, e.g., for Pe=1.0, V(t=1) ≈ 0.45 Λ r (Ring 1, D=0.1), stable under $(\gamma\Delta t < 1/2)$.

To derive equilibrium: Solve $(\dot{V} = 0) : (V^* = \frac{\Lambda r + C\sum E_{ij} - gh}{k + D_j})$. For initial V(0)=0, integrate: $(V(t) = V^*(1 - e^{-(k+D_j)t}))$. Bounded: $(|V(t) - V^*| \leq |V(0) - V^*|e^{-(k+D_j)t})$. Lyapunov proof: $(\dot{L} = (V - V^*)\dot{V} = (V - V^*)[-(k + D_j)(V - V^*) + O(1)] \leq -(k + D_j)(V - V^*)^2 \leq 0)$. Converges monotonically to 0.