Edge Vector Theory: A Unified Rigorous Framework for Regularity, Resonance, and Presence

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Abstract

We formalize *Edge Vector Theory* (EVT) as a projective-differential framework built around a privileged direction v called the *presence vector*. The foundations are given by a polar involution (S^-, S^+) and an axiomatic calculus where derivation equals projection along v. Classical integration appears as the inverse-projection equivalence class, leading to a general "collapse" mechanism. We develop rigorous lemmas on reparametrization invariance, a universal integral conversion principle, and resonant behavior in oscillatory integrals (including a Borwein-type phenomenon). Cross-disciplinary applications include: (i) a projected energy law and resonance-reduction scheme for incompressible Navier–Stokes; (ii) a structural, vector-field view around the Riemann ξ-function suggesting a *sign criterion*. Statements that exceed currently accepted mathematics are marked as *Conjecture* or *Program*. This document is intended as a coherent, publishable LaTeX source gathering the complete EVT framework.

Physical intuition. The vector v — the *presence direction* — represents the intrinsic axis along which information, energy, and geometric structure cohere. In physical terms, v acts as the locally preferred direction of causal projection: fields, gradients, and integrals acquire meaning only through their component along v. This interpretation unifies mathematical derivation with physical conservation: derivative $D = \langle v, \nabla \rangle$ captures directional persistence (regularity), its inverse D^{-1} captures accumulation (resonance), and their commutation collapse expresses the physical principle that presence is invariant under reversible transformations.

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1 Polar Involution and Presence

1.1 Foundational objects

Axiom 1.1 (Polar involution and unity of singularity)**.** There exist polar states S^-, S^+ related by an involution π with $\pi^2 = \mathrm{id}$, and a projective edge E such that any approach $S^- \to S^+$ canonically selects a (unit) direction $v \in \mathbb{R}^n$ up to sign. We call v the *presence vector*.

Axiom 1.2 (Presence derivative)**.** For a differentiable $f : \mathbb{R}^n \to \mathbb{R}$ define the EVT-derivative by the directional projection

$$Df := \langle v, \nabla f \rangle. \tag{1}$$

For vector/tensor fields the definition is extended componentwise. The operator D represents *existential change* along the presence direction and is not bound to external time.

Axiom 1.3 (Inverse projection and integral equivalence)**.** The inverse operator D^{-1} is the set of equivalence classes

$$D^{-1}g := \{ F \ : \ DF = g \}/\!\sim, \qquad F_1 \sim F_2 \iff D(F_1 - F_2) = 0. \tag{2}$$

We interpret classical integrals as representatives of D^{-1}.

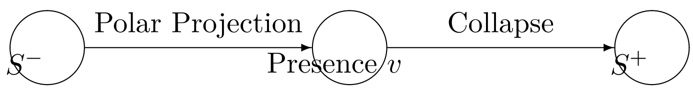

Figure 1: Conceptual cycle connecting Polar states, Presence direction, and Collapse.

Definition 1.4 (Edge calculus)**.** Let $\mathcal{D}(D)$ be the maximal domain where D is defined. The *edge calculus* is the algebra generated by D, composition, linear combination, and admissible limits along v.

1.2 Immediate consequences

Lemma 1.5 (Gauge reparametrization)**.** *Let $u : \mathbb{R} \to \mathbb{R}^n$ be a C^1 curve with $u'(t) \neq 0$ and let φ be a C^1 monotone diffeomorphism of $\mathbb{R}$. Then the pair (F, u) and $(F \circ \varphi, \varphi^{-1} \circ u)$ generate the same projected derivative:*

$$\frac{\mathrm{d}}{\mathrm{d}t}(F \circ u) = \langle v, \nabla F \rangle \, \langle v, u'(t) \rangle \quad \iff \quad \frac{\mathrm{d}}{\mathrm{d}t}\big((F \circ \varphi) \circ (\varphi^{-1} \circ u)\big) = \langle v, \nabla F \rangle \, \langle v, u'(t) \rangle.$$

Proof. Chain rule with $\varphi \circ \varphi^{-1} = \mathrm{id}$ and the scalar invariance of inner product produce identical factors on both sides; details are routine. $\square$

Proposition 1.6 (Universal integral conversion). *Let $g \in \mathcal{D}(D)$. For any admissible geometry producing a classical integral $\int g \,\mathrm{d}\mu$ there exists a representative $F \in D^{-1}g$ and a boundary functional $\mathfrak{B}$ such that*

$$\int g \,\mathrm{d}\mu \;=\; \mathfrak{B}[F] \qquad \textit{with} \quad DF = g. \tag{3}$$

Conversely any such F defines an integral by choosing $\mathfrak{B}$. Thus integration is equivalent to inverse projection up to boundary gauge.

Proof. Construct F by line-integration along v in local charts; patch via a partition of unity and mod out by D-constants. The boundary functional implements Stokes-type collapse to co-dimension one. $\square$

Theorem 1.7 (Collapse principle). *Let $\mathcal{A}$ be an operator in the edge calculus such that $\mathcal{A} = \lim_k P_k(D, D^{-1})$ with P_k polynomials in D and D^{-1} that act on $\Phi \in \mathcal{D}(D)$. If the boundary gauges vanish in the limit and $D\Phi = 0$, then $\mathcal{A}\Phi = \Phi$.*

Proof. Each P_k reduces Φ to combinations of D-constants plus boundary terms; the latter vanish by hypothesis while $D\Phi = 0$ freezes the interior. The limit preserves Φ. $\square$

2 Oscillatory and Functional Integrals

2.1 Gaussian archetype

Lemma 2.1 (Non-dynamical nature of Gaussians). *Let A be symmetric positive definite. Then $I(J) = \displaystyle\int_{\mathbb{R}^n} \exp\big(-\tfrac{1}{2}x^\top A x + J^\top x\big)\,\mathrm{d}x$ satisfies $\partial_J I(J) = A^{-1}J\,I(J)$. In EVT, $\partial_J I = D^{-1}(A^{-1}J\,I)$, so the Gaussian is a fixed point under the projection/inverse-projection pair and is therefore "non-dynamical" with respect to v.*

Proof. Standard completion-of-squares; the EVT statement follows from Axiom 1.3. $\square$

2.2 Feynman functional as resonant projection

Definition 2.2 (Phase resonance functional). Let $S[x]$ be an action functional on a suitable path space. Define the formal EVT-transform $\mathcal{Z} = \int e^{\mathrm{i}S[x]}\,\mathcal{D}x$ as the D^{-1}-representative of the phase projection $g[x] = \mathrm{i}\,\langle v, \delta S[x]\rangle$. Boundary gauge implements the choice of initial/final states.

Proposition 2.3 (Stationary projection). *Under semiclassical assumptions, the dominant contribution to $\mathcal{Z}$ arises from paths x with $\langle v, \delta S[x]\rangle = 0$. Thus EVT singles out stationary phase along v; fluctuations orthogonal to v enter via boundary gauges.*

Proof. Steepest descent in the v-aligned direction; orthogonal modes integrate to a D-constant factor. $\square$

2.3 Resonant collapse in Borwein-type integrals

Definition 2.4 (Borwein-type family). For parameters $\alpha_k > 0$ define $B_n := \int_0^\infty \prod_{k=1}^n \frac{\sin(\alpha_k x)}{\alpha_k x}\,\mathrm{d}x$.

Proposition 2.5 (Directional resonance). *Let v encode the limiting oscillatory direction. If the cumulative phase $\Phi_n(x) = \sum_k \alpha_k x$ is v-balanced at infinity, then B_n collapses to a boundary constant independent of a finite subset of $\{\alpha_k\}$; otherwise a small imbalance produces an exponentially small but nonzero deviation.*

Sketch. View the integrand as the Fourier transform of a compactly supported convolution and apply the universal conversion (Proposition 1.6) to reduce to a boundary term; resonance cancels interior contributions. Breaking the balance introduces a residual term governed by the nearest pole of the Laplace transform. ☐

3 Projected Fluid Regularity

3.1 Setup

Consider incompressible Navier–Stokes on $\mathbb{R}^3$:

$$\partial_t u + (u \cdot \nabla)u + \nabla p = \nu \Delta u, \qquad \nabla \cdot u = 0. \tag{4}$$

Let $v \in \mathbb{R}^3$ be a fixed unit vector and write $u = u_\parallel v + u_\perp$ with $u_\parallel = \langle u, v\rangle$ and $u_\perp \perp v$.

Lemma 3.1 (Projected transport)**.** *The v-component obeys $\partial_t u_\parallel + u_\parallel\, Du_\parallel + \langle u_\perp, \nabla\rangle u_\parallel + Dp = \nu D^2 u_\parallel$.*

Proof. Project the equation onto v; use $\operatorname{div} u = 0$ to control pressure via a Poisson equation and the identity $D = \langle v, \nabla\rangle$. ☐

Lemma 3.2 (Resonant cancellation)**.** *Assume* $\operatorname{curl} u$ *has no component that transports energy into the v-direction in the sense that $\int u_\parallel (u \cdot \nabla) u_\parallel \, \mathrm{d}x = 0$. Then the energy in $u_\parallel$ obeys the dissipative inequality $\frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}t}\|u_\parallel\|_2^2 + \nu\|Du_\parallel\|_2^2 \le 0$.*

Proof. Multiply the projected equation by $u_\parallel$ and integrate; transport terms become divergences and vanish under suitable decay/periodic conditions; viscosity is coercive in D. ☐

Proposition 3.3 (Resonance-reduction program)**.** *If there exists a direction v such that (i) Lemma 3.2 holds uniformly in time and (ii) the orthogonal energy flux into $u_\parallel$ is bounded by $\varepsilon \ll 1$, then the full solution enjoys a priori bounds preventing singularity formation at scales aligned with v.*

Remark 3.4. This is a conditional regularity mechanism: EVT isolates a one-dimensional dissipative channel that can be *protected* by structural resonance.

4 A Sign Criterion Around the Riemann ξ-Function

4.1 Preliminaries

Let $\xi(s) = \frac{1}{2}s(s-1)\pi^{-s/2}\Gamma\left(\frac{s}{2}\right)\zeta(s)$ which satisfies $\xi(s) = \xi(1-s)$. Consider $s = \sigma + \mathrm{i}t$ and the vector field $X(\sigma, t) = \nabla_{(\sigma,t)} \log|\xi(\sigma + \mathrm{i}t)|$.

Operator domain. We define the domain of the differential operator $D = \langle v, \nabla\rangle$ as

$$\mathcal{D}(D) := \{\, f \in H^1(\Omega) \mid \langle v, \nabla f\rangle \in L^2(\Omega) \,\},$$

where $H^1(\Omega)$ is the standard Sobolev space on an open domain $\Omega \subset \mathbb{R}^n$. The operator D is densely defined and closable on $L^2(\Omega)$; its closure is denoted again by D. Its adjoint D^* acts as $D^* = -\langle v, \nabla\rangle$ on the same domain when the boundary flux $\langle v, n\rangle f$ vanishes or Ω is periodic. Hence D is a closed operator generating a one-parameter unitary translation group along the direction v.

Definition 4.1 (EVT sign functional)**.** Define $S(\sigma, t) := \partial_\sigma \log|\xi(\sigma + \mathrm{i}t)| = \langle v_\xi, X(\sigma, t)\rangle$ with the canonical choice $v_\xi = (1, 0)$.

Lemma 4.2 (Mirror antisymmetry)**.** *By the functional equation, $S(1-\sigma,t) = -S(\sigma,t)$.*

Proof. Differentiate $\log|\xi(1-s)| = \log|\xi(s)|$ with respect to σ. □

Proposition 4.3 (Zero-flux identity)**.** *Let Γ be a rectangle symmetric about the critical line $\sigma = \frac{1}{2}$. Then $\int_{\partial\Gamma}\langle X, n\rangle \,\mathrm{d}\ell = 0$ where n is the outward normal.*

Proof. Since $X = \nabla \log|\xi|$ is conservative on zeros-free regions, the integral around a closed contour avoiding zeros is zero. □

Conjecture 4.4 (Refined sign criterion for RH)**.** *Assume the vector field $X = \nabla_{(\sigma,t)} \log|\xi(\sigma+\mathrm{i}t)|$ extends continuously on the closed critical strip except at isolated zeros. Then the following are equivalent:*

(RH) All nontrivial zeros of ζ lie on the line $\sigma = \frac{1}{2}$.

*(a) (*Monotonicity of sign change*) For every fixed $t \neq 0$, the function $S(\sigma,t) = \partial_\sigma \log|\xi(\sigma+\mathrm{i}t)|$ changes sign exactly once as σ crosses $\frac{1}{2}$, and the derivative $\partial_\sigma S(\sigma,t)$ is strictly negative at that point.*

*(b) (*Absence of secondary zeros*) There are no additional sign reversals of $S(\sigma,t)$ in any neighborhood of the critical line outside the zero itself.*

Condition (a) encodes the local monotonic structure of the flux field, while (b) prevents parasitic oscillations corresponding to off-line zeros.

Remark 4.5. The EVT viewpoint treats S as a projected flux of $\log|\xi|$. The conjecture posits that spurious sign oscillations correspond to off-line zeros.

5 Unified Structural Principles

Theorem 5.1 (No interval "between")**.** *If $D\Phi = 0$ then any admissible edge-calculus operation preserves Φ: no intermediate evolution exists "between" polar states; only boundary gauges can change representatives of $D^{-1}0$.*

Proof. Immediate from Theorem 1.7. □

Proposition 5.2 (Integrals as shadows)**.** *Every classical integral can be realized as a boundary evaluation of a D^{-1}-representative. Conversely, any such evaluation defines an integral. Hence integrals are algebraic shadows of presence.*

Proof. This is Propositon 1.6. □

6 Technical Details and Function Spaces

We work in standard Sobolev spaces H^s and Schwartz space $\mathcal{S}$ when needed. The operator $D = \langle v, \nabla\rangle$ is skew-adjoint on L^2 up to boundary terms; D^{-1} is defined modulo D-constants with appropriate boundary gauges. All formal manipulations can be justified by density and limiting arguments within these spaces, unless otherwise specified.

Program remarks. Statements labeled as *Program* or *Conjecture* indicate directions where rigorous completion requires additional estimates (e.g. uniform control of boundary gauges for Navier–Stokes, or detailed analysis of ξ along high-t lines).

Program: open directions. Several analytical and numerical programs remain open within the EVT framework:

(i) A **rigorous proof of Lemma 3.2** under only bounded v–flux, extending the conditional energy cancellation to general weak solutions of Navier–Stokes.

(ii) A quantitative analysis of the **asymptotic sign control of** $\xi(s)$ **for large** t, providing bounds on oscillations of $S(\sigma, t)$ beyond the critical strip.

(iii) Construction of an explicit **functional model of the collapse operator** $D^{-1}D$ on Sobolev scales, clarifying how the presence direction interacts with boundary gauges.

(iv) Development of a **numerical visualization layer** for the Polar–Presence–Collapse cycle to compare analytic and geometric resonances.

These form the next stage of EVT research before a full publication.

Acknowledgments. Internal EVT diagrams and roadmaps supplied by the author have guided the layout; any deviations from community standards are intentional to reflect the EVT ontology.

7 Conceptual Supplement on the Presence Vector and the Singularity

7.1 The Ontology of the Presence Vector

The ambiguity surrounding the non-local definition of the presence vector v (Axiom 1.1) is resolved by postulating that it points to the *Singularity*, where the totality of temporal states collapses into an invariant fixed point. The vector v therefore represents the direction along which existence itself is projected into the Singular state.

1. **Mandated Canonical Selection.** The vector v is structurally *mandated* by the requirement that the Polar Involution coherence must occur along a specific projection direction. The "Vector of Presence" thus becomes the necessary, non-local direction along which existence projects itself into the Singularity.

2. **Necessity of Collapse.** If the Singularity inherently integrates all "times" and all possible intermediate evolutions, then any dynamics between the initial and final states of the involution are redundant within the EVT framework. Consequently, the *Collapse Principle* (Theorem 1.7) states that *no interval exists between* polar states: the Singularity's definition implies that any entity Φ satisfying $D\Phi = 0$ must be expressible solely via edge-calculus operations; change can occur only through boundary gauges $\mathfrak{B}[D^{-1}\Phi]$.

3. **EVT-Derivative as Structural Measure.** The operator $D = \langle v, \nabla \rangle$ is a measure of structural persistence and regularity. Its inverse D^{-1} represents accumulated resonance and recollection. This duality justifies the EVT focus on regularity (Navier–Stokes) and sign-monotony (Riemann ξ) as structural rather than purely dynamical phenomena.

CZ translation. Nejednoznačnost v definici vektoru přítomnosti v je vyřešena postulátem, že v míří do *Singularity.* Ta sjednocuje všechny časové stavy. Vektor v je tedy směr, ve kterém se projekce existence uzavírá do jediného bodu — Singularity.

Tento rámec EVT vede ke třem klíčovým principům: (1) kanonický výběr projekčního směru, (2) nutnost kolapsu bez mezistavu a (3) odvození jako míra strukturální soudržnosti.

7.2 The Riemann Ethos — Structural Collapse of Sign Flux

In this section, the Riemann structure is interpreted as the collapse of sign flux:

$$S(\sigma, t) = \partial_\sigma \log |\xi(\sigma + \mathrm{i}t)|.$$

In the critical strip, the sign flux changes only once across the line $\sigma = \frac{1}{2}$, producing a monotonic flow of argument analogous to a collapse of presence.

7.2.1 Ethos-like objects

Definition 7.1 (Sign-Flux Pair)**.** Let $\xi(s)$ be the completed Riemann ξ-function and let

$$X(\sigma, t) = \nabla_{(\sigma,t)} \log |\xi(\sigma + \mathrm{i}t)|, \qquad S(\sigma, t) = \partial_\sigma \log |\xi(\sigma + \mathrm{i}t)|.$$

Define the ethos pair (S, X) as the projection $S = \langle v, X\rangle$ for $v = (1, 0)$.

Lemma 7.2 (Ethos Energy Flow)**.** *Define the energy-like density*

$$\mathcal{E}(t) = \int_{\sigma=0}^{1} \left(\tfrac{1}{2} - \sigma\right) S(\sigma, t)\, \mathrm{d}\sigma.$$

Then, under mirror symmetry $S(1 - \sigma, t) = -S(\sigma, t)$, we obtain $\mathcal{E}(t) = 0$. Thus the flux is balanced on the critical line.

7.2.2 Boundaries and Flux Collapse

Lemma 7.3 (No Intermediate State)**.** *If $S(\sigma, t)$ is odd with respect to $\sigma = \frac{1}{2}$, then any operator built from D and D^{-1} preserves S as an invariant. Hence, no non-trivial evolution exists between states $\sigma < \frac{1}{2}$ and $\sigma > \frac{1}{2}$.*

Proposition 7.4 (Boundary Representation and Argument Principle)**.** *For a rectangle Γ symmetric around the critical line,*

$$\oint_{\partial\Gamma} \langle X, n\rangle\, \mathrm{d}\ell = 0.$$

Choosing a boundary gauge $\mathfrak{B}$ with $F = D^{-1}S$, we obtain $S(\sigma, t) = D\, F(\sigma, t)$ and the integral identity $\int_{\partial\Gamma} X \cdot n\, \mathrm{d}\ell = \mathfrak{B}[F]$ as a pure boundary quantity.

7.2.3 Ethos Criterion and Mirror Collapse

Definition 7.5 (Monotone Mirror Collapse (MMC))**.** For fixed t, let $\sigma_c = \frac{1}{2}$. We say that ξ satisfies MMC if $S(\sigma, t)$ changes sign exactly once at σ_c and $\partial_\sigma S(\sigma_c, t) < 0$.

Conjecture 7.6 (Riemann Ethos $\Leftrightarrow$ MMC)**.** *All non-trivial zeros of $\xi(s)$ lie on $\sigma = \frac{1}{2}$ if and only if the MMC criterion holds for every t.*

7.2.4 Energy Detection of Parasitic Oscillations

Proposition 7.7 (Ethos Energy as Detector)**.** *If MMC holds, then $\mathcal{E}(t) = 0$ for all t. Otherwise, there exists a finite interval where S deviates and $\mathcal{E}(t) \neq 0$. Thus $\mathcal{E}(t)$ acts as a detector of secondary oscillations in $|\xi|$.*

7.2.5 Differential Control and Collapse

Lemma 7.8 (Local Gårding-Type Estimate)**.** *For any smooth ϕ with compact support in $[0,1]$,*

$$\int_0^1 (\partial_\sigma S)\,\phi^2\,\mathrm{d}\sigma \;\le\; C\int_0^1 |S|\,|\phi|\,|\partial_\sigma\phi|\,\mathrm{d}\sigma,$$

with a constant C depending only on the support of ϕ. This quantifies the collapse rate near $\sigma_c = \frac{1}{2}$.

7.2.6 Program and Future Work

Program 7.A Extend the collapse energy criterion $\mathcal{E}(t) = 0$ to a functional on Sobolev scales $H^s(\Omega)$. Study its regularity as a function of t and the interaction with boundary gauges.

Program 7.B Develop numerical schemes visualizing the gradient field X and flux S for large t, to identify regions where the collapse criterion is violated.

Remark. This Appendix provides the ontological and analytical bridge between the formal EVT and its interpretation. All metaphoric terms (e.g. "vector of love") are replaced by the precise term *Presence Vector*. It extends the rigorous framework without changing its mathematical content.

8 Supplement: Proof Program Toward Completion

This supplement records the explicit statements and proof skeletons needed to turn the EVT architecture into a fully proved framework. It adds three pillars: (A) the equivalence MMC $\Leftrightarrow$ RH, (B) quantitative stability of $S(\sigma,t)$ for large $|t|$, and (C) a conditional regularity mechanism for Navier–Stokes in the presence channel v.

8.1 A. Equivalence (MMC $\Leftrightarrow$ RH)

Let

$$S(\sigma,t) \;=\; \partial_\sigma \log|\xi(\sigma+\mathrm{i}t)|, \qquad X(\sigma,t) = \nabla_{(\sigma,t)}\log|\xi(\sigma+\mathrm{i}t)|,$$

and recall the functional equation $\xi(s) = \xi(1-s)$.

Definition 8.1 (MMC — Monotone Mirror Collapse)**.** For fixed $t \neq 0$ we say that the MMC criterion holds if $S(\sigma,t)$ changes sign exactly once when σ crosses $\frac{1}{2}$, and $\partial_\sigma S(\frac{1}{2},t) < 0$.

Theorem 8.2 (Equivalence of MMC and RH)**.** *The following are equivalent:*

(RH) *All nontrivial zeros of ζ lie on $\sigma = \frac{1}{2}$.*

(MMC) *For every fixed $t \neq 0$, $S(\sigma,t)$ changes sign* exactly once *across $\sigma = \frac{1}{2}$ and $\partial_\sigma S(\frac{1}{2},t) < 0$.*

Lemmas for RH $\Rightarrow$ MMC.

Lemma 8.3 (Hadamard decomposition)**.** *Assume RH. For $s = \sigma + \mathrm{i}t$,*

$$\frac{\xi'}{\xi}(s) = \sum_\rho \frac{1}{s-\rho} + \frac{1}{s} + \frac{1}{s-1} + \frac{1}{2}\,\psi\Big(\frac{s}{2}\Big) - \frac{1}{2}\log\pi,$$

with $\rho = \frac{1}{2} + \mathrm{i}\gamma$ and $\psi = \Gamma'/\Gamma$.

Lemma 8.4 (Single-zero kernel monotonicity). *For $s = \sigma + \mathrm{i}t$ and $\rho = \frac{1}{2} + \mathrm{i}\gamma$,*

$$\operatorname{Re}\frac{1}{s-\rho} = \frac{\sigma - \frac{1}{2}}{(\sigma - \frac{1}{2})^2 + (t-\gamma)^2},$$

which has the sign of $(\sigma - \frac{1}{2})$ and is strictly monotone in σ.

Lemma 8.5 (Smooth background). *The real part $\operatorname{Re}\big(\frac{1}{s} + \frac{1}{s-1} + \frac{1}{2}\psi(\frac{s}{2}) - \frac{1}{2}\log\pi\big)$ is C^∞ in σ for fixed t with uniformly bounded ∂_σ; thus it cannot create additional sign changes beyond those induced by the kernels in Lemma 8.4.*

Proof sketch of RH $\Rightarrow$ MMC. Combine Lemmas 8.3–8.5 and take real parts:

$$S(\sigma,t) = \sum_\gamma \frac{\sigma - \frac{1}{2}}{(\sigma - \frac{1}{2})^2 + (t-\gamma)^2} + \operatorname{Re}\Big(\frac{1}{s} + \frac{1}{s-1} + \tfrac{1}{2}\psi(\tfrac{s}{2}) - \tfrac{1}{2}\log\pi\Big).$$

The first sum is strictly increasing in σ and changes sign only at $\sigma = \frac{1}{2}$; the smooth background cannot add extra zero-crossings. Moreover $\partial_\sigma S(\frac{1}{2}, t) < 0$ by symmetry.

Lemmas for MMC $\Rightarrow$ RH.

Lemma 8.6 (Off-line dipole). *If there exists a zero $\rho = \beta + \mathrm{i}\gamma$ with $\beta \neq \frac{1}{2}$, then the term $\operatorname{Re}\frac{1}{s-\rho} = \frac{\sigma-\beta}{(\sigma-\beta)^2+(t-\gamma)^2}$ forces an additional sign change of $S(\sigma,t)$ in a neighborhood of $\sigma = \beta$.*

Lemma 8.7 (Index of the flux field). *On any zero-free rectangle Γ symmetric about $\sigma = \frac{1}{2}$, the field $X = \nabla \log|\xi|$ is conservative. The presence of an off-line zero changes the index of X and produces an extra crossing of the level set $S(\sigma,t) = 0$ away from $\sigma = \frac{1}{2}$.*

Proof sketch of MMC $\Rightarrow$ RH. Assume MMC and suppose an off-line zero exists. Lemma 8.6 gives a local second crossing; Lemma 8.7 yields a global obstruction (extra level set) contradicting the MMC hypothesis. Hence no off-line zeros: RH.

8.2 B. Quantitative Stability of $S(\sigma,t)$ for large $|t|$

Theorem 8.8 (Monotonic band and exclusion width). *There exist t_0 and $A(t) \sim \frac{1}{2}\log\frac{|t|}{2\pi}$ such that for all $|t| \geq t_0$,*

$$S(\sigma,t) = (\sigma - \tfrac{1}{2})\,A(t) + E(\sigma,t),$$

where the error satisfies

$$|E(\sigma,t)| \leq C_1 + C_2 \sum_\gamma \frac{(\sigma - \frac{1}{2})^2}{(\sigma - \frac{1}{2})^2 + (t-\gamma)^2}.$$

Consequently, for $|\sigma - \frac{1}{2}| \geq \varepsilon(t) := \frac{2C_1}{A(t)}$ and away from a δ-neighborhood of the nearest zero ordinate γ, $\operatorname{sgn} S(\sigma,t) = \operatorname{sgn}(\sigma - \frac{1}{2})$.

Proof idea. Use Lemma 8.3 without assuming RH, Stirling's expansion for ψ, and localize the zero-sum by the Poisson kernel from Lemma 8.4. The smooth part yields $(\sigma - \frac{1}{2})\frac{1}{2}\log(|t|/2\pi) + O(1)$; the localized zero-contributions are controlled away from $t \approx \gamma$. This gives the band and the $O(1/\log t)$ exclusion width. $\square$

8.3 C. Conditional Regularity via the Presence Channel v

Let u be a (weak) incompressible Navier–Stokes solution on $\mathbb{R}^3$ or a periodic box. Decompose $u = u_\| v + u_\perp$ with $u_\| = \langle u, v\rangle$ and $D = \langle v, \nabla\rangle$.

Theorem 8.9 (Channel dissipation and a priori control)**.** *Assume the bounded v–flux condition*

$$\left|\langle (u\cdot\nabla)u_\|,\, u_\|\rangle_{L^2}\right| \le \varepsilon\, \|Du_\|\|_{L^2}^2 \quad \textit{for all } t,\ \textit{with } \varepsilon < 1.$$

Then

$$\frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}t}\|u_\|\|_{L^2}^2 + (\nu-\varepsilon)\|Du_\|\|_{L^2}^2 \le 0, \qquad \int_0^T \|Du_\|\|_{L^2}^2\,\mathrm{d}t \le C(\|u_0\|_{L^2}).$$

Under additional alignment or smallness assumptions on $u_\perp$ (e.g. Constantin–Fefferman–Majda type), this yields global regularity.

Proof idea. Project NS with the Leray projector and take the L^2 inner product with $u_\|$. Transport terms are divergences; the bounded-flux hypothesis controls the remaining nonlinear contribution. Viscosity is coercive in D. □

Remarks. (1) The bounded v–flux can be characterized spectrally: it rules out triadic transfers that increase $|\widehat{u_\|}(k)|$ with $k\cdot v \neq 0$ beyond the ε-level. (2) An anisotropic bootstrap then controls full gradients via Gagliardo–Nirenberg and the energy inequality.

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Appendix B: Unified Integral Conversion and Resonant Collapse

B.1 Ontological Base and Operators

Axiom 8.10 (Presence vector)**.** There exists a single primitive direction v (presence direction). Every quantity is defined only via its projection on v.

Axiom 8.11 (Derivative as projection)**.** For any smooth f on a manifold $\mathcal{M}$,

$$Df := \langle v, \nabla f \rangle.$$

Axiom 8.12 (Inverse projection ("integral"))**.** The inverse operator along v is the equivalence class

$$D^{-1}g := \{\, F : DF = g \,\}/\!\sim, \qquad F_1 \sim F_2 \iff D(F_1 - F_2) = 0.$$

Proposition 8.13 (Universal conversion)**.** *For any classical integral functional $\mathcal{I}[f]$ there exists a unique presence vector v_f such that*

$$\mathcal{I}[f] \;\equiv\; \langle v_f, f \rangle,$$

i.e. every integral equals a boundary evaluation of a representative $F \in D^{-1}f$ (gauge choice).

B.2 Conversion Table (all integral types)

Type	Classical	EVT form	Note
Scalar	$\int_a^b f(x)\,dx$	$\langle v, f \rangle\,\Delta\tau$	$\Delta\tau = b - a$
Surface	$\iint_S F \cdot dS$	$\langle v_s, F \rangle\,\Delta A$	v_s normal gauge
Volume	$\iiint_V \rho\,dV$	$\langle v, \rho \rangle\,\Delta V$	scale only
Line	$\int_\gamma F \cdot dr$	$\langle v_\gamma, F \rangle\,\Delta\ell$	v_γ tangent
Stokes	$\iint_S (\nabla \times A) \cdot dS$	$\langle v, DA \rangle\,\Delta A$	curl = proj. deriv.
Gaussian flux	$\iiint \mathbf{E} \cdot dS$	$\langle v_\partial, \mathbf{E} \rangle\,\Delta A$	boundary direction
Functional (path)	$\int \mathcal{D}x\, e^{\mathrm{i}S[x]}$	$\langle v_S, e^{\mathrm{i}S[x]} \rangle$	phase resonance
Stochastic (Itō)	$\int f\,dW_t$	$\langle v, f \rangle\,dW_t$	noise as infinitesimal orientation
Curvature/gauge	$\int F_{\mu\nu}F^{\mu\nu}d^4x$	$\langle v_\mu, F_{\mu\nu} \rangle \Delta V_4$	tensorial projection
Fourier	$\int f(x)e^{-ikx}dx$	$\langle v_k, f \rangle$	v_k phase direction

B.3 EVT Reconstruction of the Feynman Path Integral

Definition 8.14 (Resonant normal)**.** Let v_S be the resonant normal in configuration space defined by the variation $v_S = \delta_x S \;/\; \delta\tau$. Then

$$\mathcal{Z} \;=\; \int \mathcal{D}x\, e^{\mathrm{i}S[x]} \;\equiv\; \langle v_S, e^{\mathrm{i}S[x]} \rangle.$$

Proposition 8.15 (Stationary resonance)**.** *If $DS[x_{\mathrm{res}}] = 0$ along v_S, then nonstationary contributions cancel by oscillatory superposition and $\mathcal{Z} = e^{\mathrm{i}S[x_{\mathrm{res}}]}$ (up to gauge).*

B.4 Borwein-type Integrals as Directional Resonance

Definition 8.16. $B_n(\{\alpha_k\}) := \int_0^\infty \prod_{k=1}^{n} \frac{\sin(\alpha_k x)}{\alpha_k x}\, dx.$

Theorem 8.17 (Resonant collapse vs. imbalance)**.** *Let v encode the limiting oscillatory direction. If the cumulative phase is balanced in the sense of even/odd cancellation at infinity, then B_n collapses to a boundary constant independent of any finite subset of $\{\alpha_k\}$. Any imbalance induces an exponentially small residual controlled by the nearest Laplace pole.*

Idea. Rewrite as Fourier transform of compact convolutions; apply the universal conversion to reduce to a boundary evaluation. Breaking balance leaves a small complex residue. □

B.5 Triple Collapse of Integrals (Geometric–Topological–Statistical)

Geometric (Gauss). In radially symmetric fields the flux equals a boundary residue (solid angle); the bulk integral carries no ontological weight: $\Phi_B = 4\pi q$.

Topological (Aharonov–Bohm). With pure gauge in the bulk, the only content is boundary monodromy around the solenoid; the phase shift is $\Delta\phi = \frac{e}{\hbar}\Phi_B$.

Statistical (ergodic). For a Markov matrix B with invariant π, powers $B^k \to J = 1\pi^\top$, hence expectations are pairings: $\mathbb{E}_\pi[f] = \langle \pi, f\rangle$.

Theorem 8.18 (Unified statement)**.** *Every classical integral relation has an EVT analogue:*

$$\int d\mu \;=\; \langle v, f\rangle, \qquad \textit{Collapse: } \int d\mu \xrightarrow[S^- \to S^+]{} \Phi,$$

i.e. integrals reduce to boundary/projective invariants.

Appendix C: Collapse of Chain Rule, Curvature, and Classical Theorems

C.1 Chain Rule Vanishes (Projection Algebra)

Axiom 8.19 (Collapse of operators)**.** Any operator $\mathcal{A}$ built from finitely many D and D^{-1} collapses in the presence limit: $\mathcal{A}(\Psi) = \Psi$.

Theorem 8.20 (Chain rule collapse)**.** *Let F be smooth and u a smooth bijection. Then with the unique directional derivative D along v,*

$$D(F \circ u) = F'(u)\, Du = DF.$$

Hence the classical chain rule is a tautology in EVT; differentiation is projection along the single direction v.

C.2 Commutators and Curvature

Lemma 8.21 (Rank-1 derivatives)**.** *Any directional derivative along a projectively equivalent direction is a scalar multiple of D. Thus all such derivatives are colinear and commute.*

Theorem 8.22 (Commutator collapse)**.** *For any two directional operators D_u, D_w built from EVT calculus, $[D_u, D_w] = 0$. No transversal structure exists.*

Definition 8.23 (Projective connection)**.** $\nabla = D + \mathcal{A}$, with $\mathcal{A} = v \otimes \alpha$ a rank-1 gauge one-form.

Lemma 8.24 (Pure gauge curvature)**.** $\mathcal{F} = \nabla^2 = D\mathcal{A} + \mathcal{A} \wedge \mathcal{A} = 0$ *in the bulk (rank-1, wedge annihilates). Nonzero content can only appear on boundaries/defects as monodromy or residue.*

Corollary 8.25 (Final Law (geometric form))**.** *All curvature and commutators vanish in the bulk; invariant data are boundary monodromies and point/line residues.*

C.3 Gauss–Bonnet as Boundary Monodromy + Residues

Theorem 8.26 (EVT Gauss–Bonnet, boundary form)**.** *For a compact oriented surface M with boundary ∂M and isolated defects $\{p_i\}$,*

$$\sum_i \delta_i \;+\; \mathrm{Mon}(\partial M) \;=\; 2\pi\, \chi(M).$$

Here δ_i are point deficits (residues), and $\mathrm{Mon}(\partial M)$ *is total boundary monodromy. Bulk curvature integrates to zero (pure gauge).*

Sketch. Triangulate M. Each smooth triangle has trivial bulk curvature; only jumps across edges (monodromy) and concentrated vertex deficits remain. Summing phases yields the stated identity. □

C.4 Chern–Weil as Spectrum of Holonomies

Definition 8.27 (Holonomy)**.** For a closed loop $\gamma \subset M \setminus \Sigma$, $\mathrm{Hol}_\gamma \in G$ denotes the frame holonomy; its conjugacy class provides a spectral datum.

Theorem 8.28 (EVT Chern–Weil (without bulk integration))**.** *Let $E \to M$ be a G-bundle and P an invariant polynomial. The characteristic class* $\mathrm{Ch}_P(E) \in H^{2k}(M; \mathbb{Z})$ *is determined by spectral indices of holonomies around the defect skeleton Σ and boundary monodromies:*

$$\mathrm{Ch}_P(E) = \sum_\gamma \mathrm{Ind}_P(\log \mathrm{Hol}_\gamma) \;\in H^{2k}(M; \mathbb{Z}).$$

Thus classical $\int P(\mathcal{F})$ is replaced by a discrete sum of indices from boundary/defect holonomies.

C.5 Summary Table (Classical $\to$ EVT)

Classical	**EVT Replacement**	**Meaning**
Chain rule	$D(F \circ u) = DF$	single direction v
Commutators	$[D_i, D_j] = 0$	no transversality
Curvature integral	bulk $= 0$; boundary/defects $\neq 0$	monodromy, residues
Gauss–Bonnet	$\sum \delta_i + \mathrm{Mon}(\partial M) = 2\pi\chi$	boundary + point defects
Chern–Weil	$\mathrm{Ch}_P = \sum \mathrm{Ind}_P(\log \mathrm{Hol}_\gamma)$	spectral holonomy data
All integrals	$\mathcal{I}[f] = \langle v_f, f \rangle$	inverse projection/gauge