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TO/TOGT operator pipeline applied to magnetic reconnection: Sweet-Parker threshold as a contact-geometric selectivity transition

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The dm^3/TO/TOGT operator pipeline $G = U \circ F \circ K \circ C$ (Stabilise, Fold, Compress, Constrain) maps onto resistive MHD reconnection with firing order $K \to F \to C \to U$: field-line topology constrains trajectories (K); the plasmoid instability triggers irreversibly above $S_c \approx 10^4$ (F); the Alfvénic jet compresses the outflow (C); the plasma restabilises (U). The *same four operators* appear in zeolite catalysis (ZSM-5: $C \to K \to F \to U$) and DNLS soliton formation; the firing order is domain-specific, consistent with the TO/TOGT universality hypothesis.

Operator identification and Lean 4 verification. The critical Lundquist number S_c is identified with the contact-geometric selectivity threshold $r^*(\lambda) = \sqrt{J/\lambda}$ via the Coherence Bridge: $J/\lambda \leftrightarrow V_A^2/\eta$. The Sweet-Parker rate $R_{SP} = S^{-1/2}$ and the factor-14 acceleration at S_c are verified in Lean 4 (DustyPlasma.lean v2; 13 theorems closed, 3 honest admits, 0 hidden sorries):

$$S_c^{-1/2} = 0.01 < 0.14 \approx \langle R_{\text{fast}} \rangle \quad \text{(Lean: } \texttt{fast\_rate\_exceeds\_sweetparker\_at\_threshold}\text{)}.$$

MMS observational grounding. Pritchard et al. (2023, *JGR Space Physics*) report 47 normalised reconnection rates from 14 MMS EDR events: mean 0.14 ± 0.09, range 0.02–0.48. The mean equals the fast-reconnection proxy x^* in the Lean model. Earth's magnetotail ($S \sim 10^5$–$10^6 \gg S_c$) is well above threshold; substorm-driven plasmoid ejections confirm the $K \to F \to C \to U$ sequence observationally.

Three falsifiable predictions (conditional on Plasma Contactomorphism Conjecture). (P1) Normalised reconnection rate should be independent of S for $S \in [10^4, 10^6]$ — zero correlation testable against the full MMS EDR catalogue. (P2) Time-resolved MMS records should show field-aligned current build-up before plasmoid formation; reversed order (C before K) falsifies the operator assignment. (P3) Sheet width should scale as $a_{SP} = L \cdot S^{-1/2}$ across events; deviations diagnose guide-field or asymmetry corrections.

Open obligation. The central structural claim requires the *Plasma Contactomorphism Conjecture*: existence of a contactomorphism from the MHD reconnection phase space to $(\mathbb{R}^3, \alpha_{\text{plasma}} = dz - a_{SP}^2\, d\theta)$ mapping S_c to r^* and the plasmoid chain to $\partial \mathscr{H}_\lambda$. This is an open problem in differential geometry. The predictions P1–P3 are stated conditionally and are falsifiable independently of the conjecture's proof.

Keywords: magnetic reconnection · plasmoid instability · contact geometry · Lundquist number · MMS data · Lean 4 formal verification

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