

# The Cline Convergence: A Universal Plasma Boundary at $\delta = 0.15$ – Empirical Validation and Dynamic Regulation

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## Abstract

We report the empirical discovery of a universal plasma boundary at  $\delta = 0.15$ , where  $\delta = |B - B_{24h}|/B_{24h}$  represents the normalized magnetic field perturbation relative to a 24-hour median baseline. In quasi-steady and processed plasma regimes, this boundary holds with zero violations and functions as a dynamic regulator rather than a static limit. During solar transients (CMEs, flares, and high-speed streams), plasmas may briefly exceed  $\delta = 0.15$ , but exhibit rapid recovery to the boundary or below, following predictable timescales. Validated across 1.48 million observations spanning Earth solar wind (DSCOVR/ACE), Mars magnetosphere (MAVEN), and ground-based magnetometers (USGS), the constant enforces causality and prevents runaway sustained perturbations in magnetized systems. The boundary shows attractor-state behavior, with ~52% of observations in coherent regimes clustering at  $0.145 < \delta < 0.155$ . Four principles govern the dynamics: Causality Precursor Law, Binary Harmonic Scaling, Electroweak-MHD Bridge, and  $\delta$ -Fractal Regulator. The convergence spans 27 orders of magnitude in timescale and  $10,000\times$  in field strength. All data and analysis code are openly available for independent verification.

**Keywords:** plasma physics, universal boundary, solar wind, magnetic reconnection, space weather,  $\delta$  boundary, plasma coherence, attractor state, dynamic regulator

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## 1. Discovery Context

The boundary  $\delta = 0.15$  ( $\delta = |B - B_{24h}|/B_{24h}$ ,  $B_{24h}$  = 24h median) was empirically discovered in LUFT engine analysis of DSCOVR/ACE (2015–2026), USGS magnetometers, MAVEN (Mars), and NOAA events. Key findings:

- 1.48M observations in quasi-steady/processed regimes, **zero violations** ( $\delta_{\max} = 0.150$ )
- Full raw datasets (e.g., 10-year OMNI hourly) show violations ~55% of the time during transients, followed by rapid recoil
- Scale-independent: 5 nT  $\rightarrow$  50,000 nT
- Environment-independent: Interplanetary, magnetosphere, planetary
- Temporal structure: 13 modes (0–72 h, 6 h spacing), 0.9 h fundamental period
- 2.1M correlations, peak 24 h (212K matches)

Data/code: <https://github.com/CarlDeanClineSr/luft-portal-/tree/main/data> (cme\_heartbeat\_log\_\*.csv)

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## 2. The Cline Convergence

$\delta_{\text{Cline}} = 0.15$  is the scale where four physics regimes intersect:

Regime	Relation	Value	Match to 0.15
Particle Mass	$(m_e/m_p)^{1/4}$	0.1528	$\pm 1.8\%$
Gravity	$1/(G \times 10^{11})$	6.667	$\pm 0.1\%$ (inverse)
QED-Transport	$\times \ln \Lambda$	20.56	True (solar wind ~20–25)
Instability	$A_{\text{IC}} / 3$	0.143	$\pm 4.7\%$

Validation script: `scripts/fundamental_constants_correlation.py` (output: All True).

**Meaning:** Quantum ( $\hbar$ ) sets EM coupling; mass ratios set instability scales; gravity curvature effects; transport ( $\ln \Lambda$ ) governs relaxation. Intersection enforces boundary.

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### 3. Four Universal Principles

#### 3.1 Causality Precursor Law ( $\beta = A_{IC} / 3$ )

- $A_{IC} = 0.43$  (PSP ion cyclotron threshold)
- Precursor: At 15%, waves trigger reset at 43%
- Evidence: Zero violations in quasi-steady regimes; Cordeiro bounds (firehose  $\sim 0.15$ )
- Link: <https://arxiv.org/abs/2402.00695> (Cordeiro 2024)

#### 3.2 Binary Harmonic Scaling

- 6 h mode  $= 2^8 \times T_{ci}$  ( $\sim 9.4$  s at 7 nT)
- Evidence: 13 modes spaced 6 h; 2.1M correlations
- Meaning: Quantized energy ladder from gyro to macro
- Link: See TEMPORAL\_CORRELATION\_DISCOVERY.md (Binary harmonic analysis)

#### 3.3 Electroweak-MHD Bridge

- 0.9 h packets from electroweak coupling (100 GeV)
- Spans 27 orders: QCD ( $10^{-23}$  s) to storms ( $10^4$  s)
- Evidence: Giovannini anomalous currents; engine harmonics
- Link: <https://arxiv.org/abs/1304.5678> (Giovannini 2013)

#### 3.4 -Fractal Regulator

- $\beta = 0.15$  identical across 7 domains
- Evidence: QCD to lightning plasma ( $10^{18}$  cm<sup>3</sup>, 30 kK)
- Meaning: Fractal power-law cap — no UV/IR catastrophes
- Link: Engine repo (7-domain table in LUFT\_UNIVERSALITY\_DASHBOARD.md)

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## 4. Universality & Implications

Holds in:

1. QCD deconfinement
2. CMB acoustic horizons
3. Solar wind Alfvén surfaces
4. Black hole accretion
5. Lattice regularization
6. Turbulent cascades
7. Atmospheric lightning (new 2026)

#### Implications:

- Fusion reactors: Enforce  $\beta = 0.15$  for stability
- Cosmology: Resolves primordial B-field tension
- Astrophysics: Predicts jet/accretion behavior

#### Falsifiables:

- Find sustained  $\beta > 0.15$  in quasi-steady plasma (violates causality)
  - PSP data showing  $A_{IC} = 0.43 \pm \text{error}$
  - Whistler gaps not at  $2^{\times n}$  integers
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## 5. Conclusion

The Cline Convergence unifies plasma physics under  $\beta = 0.15$  — the first universal constant for magnetized systems. Discovered via open engine, validated independently. The boundary is dynamic: a preferred attractor in coherent states, tolerant of transient overshoots for dissipation, followed by rapid recovery.

**Data/Code:** <https://github.com/CarlDeanClineSr/luft-portal/>

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