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# Self-Regulation of Solar Coronal Heating via the Collisionless Reconnection Condition

Dmitri A. Uzdensky

Princeton University

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# Collisionality Controls Reconnection

Plasma **Collisionality** is a **Switch** between Slow and Fast Reconnection modes:

- **Collisional Regime:**
  resistive-MHD with classical resistivity $\Rightarrow$
  Petschek reconnection mechanism doesn't work $\Rightarrow$
  **Slow** Sweet–Parker reconnection

- **Collisionless regime:**
  - Hall Reconnection
  - Anomalous resistivity

  both lead to **Fast** Petschek-like Reconnection

# COLLISIONLESS RECONNECTION CONDITION

## Criterion for Fast Collisionless Reconnection:

$$\delta_{\mathsf{SP}} < \delta_{\mathsf{collisionless}} \simeq d_i \equiv \frac{c}{\omega_{pi}}\,.$$

$$\Downarrow$$

$$\lambda_{e,\mathsf{mfp}} > L\sqrt{m_e/m_i} \simeq L/40\,.$$

$$\Downarrow$$

$$n < n_c(L,B) \sim 2\cdot 10^{10}\,\mathsf{cm}^{-3}\,B_{1.5}^{4/3}\,L_9^{-1/3}$$

# Self-Regulation of Coronal Heating

**Coronal Heating** is a Self-Regulating Process keeping plasma marginally collisionless!

- **Density controls reconnection:**
  - $n > n_c$: no reconnection $\Rightarrow$ no heating: plasma gradually cools, $n_{\text{corona}}$ drops.
  - $n_e < n_c$: rapid collisionless reconnection, energy is released.

- **Reconnection controls density:** coronal energy release $\Rightarrow$ chromospheric evaporation $\Rightarrow$ coronal density rises.

- **Closing the Loop:** $n > n_c$ in post-flare loops $\Rightarrow$ subsequent magnetic dissipation is suppressed.

Thus, although highly intermittent and inhomogeneous, corona is working to keep itself roughly at the critical density $n_c(L, B_0)$.

$\Rightarrow$ **SELF-REGULATION OF CORONAL HEATING**