Kinetic Models of Solar Wind Current Sheets

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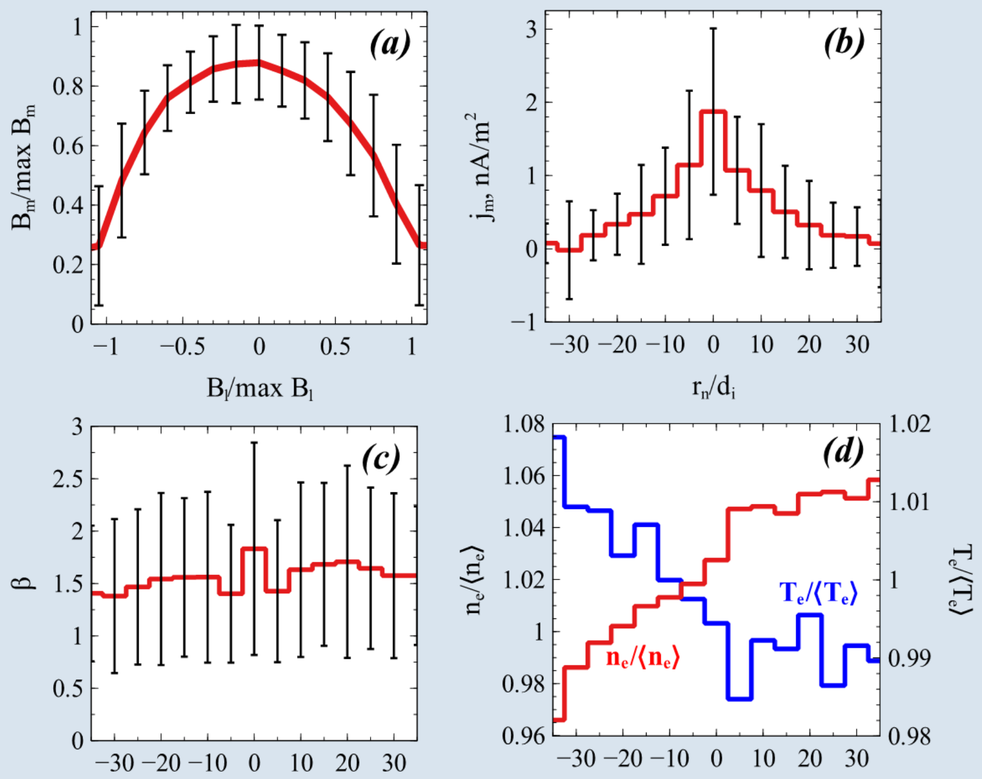
Observations

Statistical analyses by Artemyev et al. (2019) of ~200 current sheets observed in the near-Earth solar wind (at 1AU) found:

- Current sheets approximately force-free
- Magnetic field strength constant across sheet
- Plasma beta constant across sheet
- Electron density & temperature asymmetries across sheet
    - Small but systematic
    - Anti-correlated

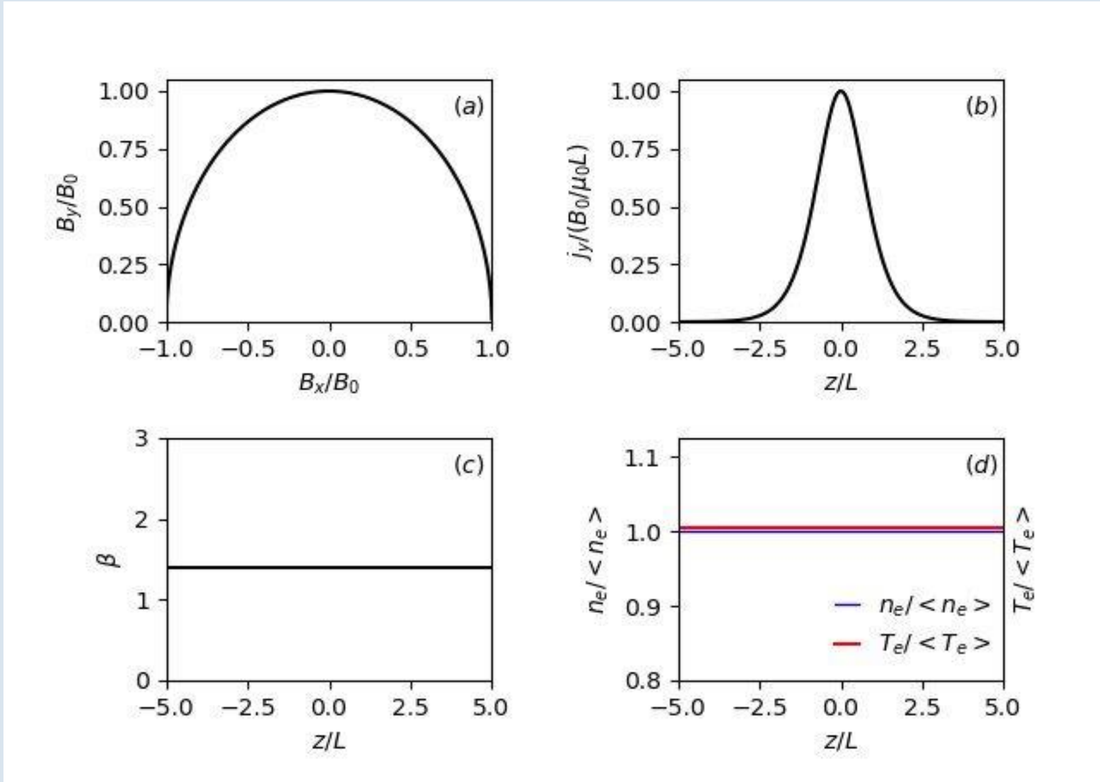


Existing Theory

Neukirch et al. (2020) modelled the observed asymmetries by adding an additional term to **both** the ion and electron distribution functions (DFs).

Quasineutrality condition is satisfied by $\Phi = 0$.

Can the asymmetries be obtained by modifying only the electron population?



Modifying Only the Electron Population

Problem – quasineutrality condition

$$n_i(A_x, A_y, \Phi) = n_e(A_x, A_y, \Phi;\ \varepsilon)$$

not satisfied by $\Phi = 0$!

Two approaches:

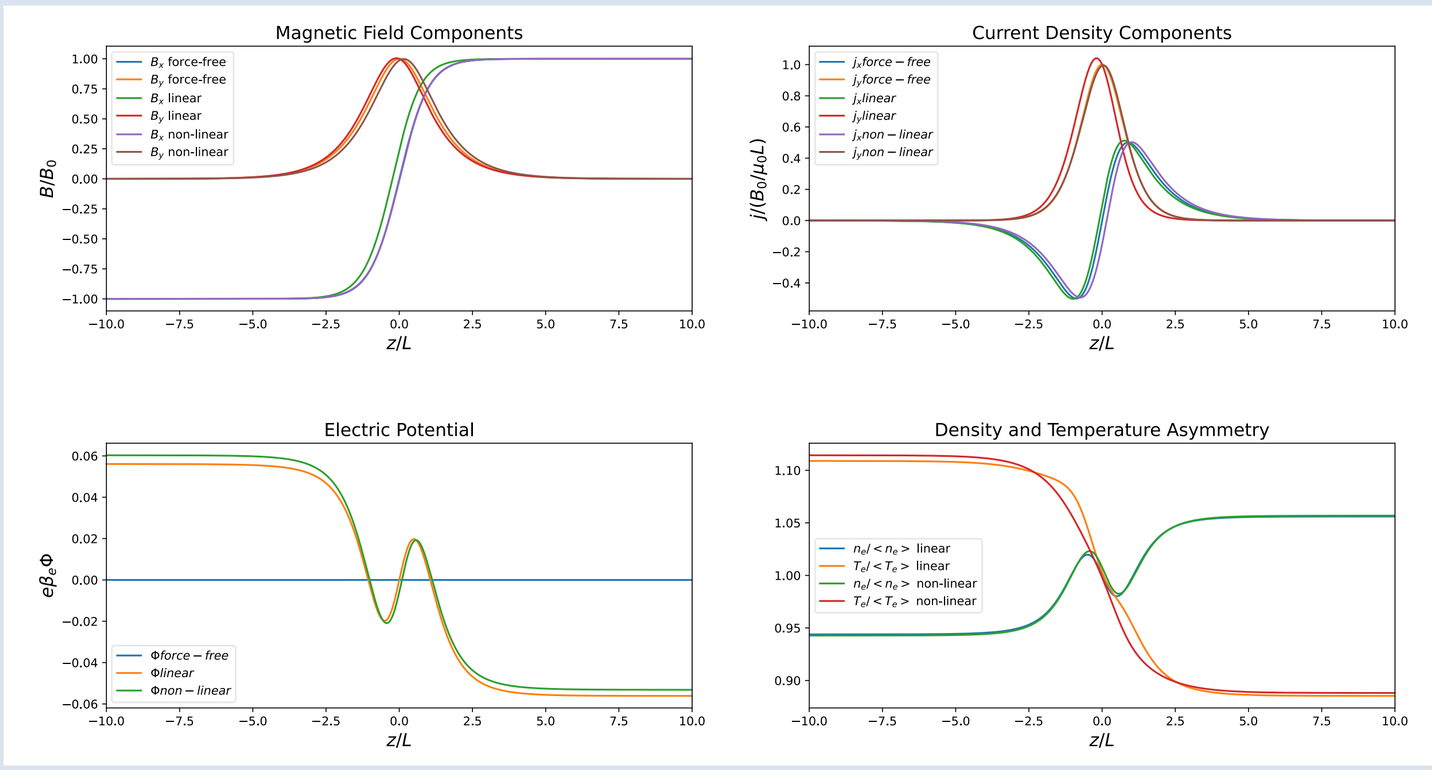
1. Linear Case

- ϵ is a small parameter
- Expand about force-free solution
- Quasineutrality condition solved **analytically**
- Ampère's law solved **numerically**

2. Non-Linear Case

- Quasineutrality condition solved **numerically** in combination with Ampère's law

Results & Discussion



- Shifting from force-free solution around $\bar{z} = 0$ due to setting conditions at the boundaries
- Electron density (n) does not match observations
- For DF forms used, it is not possible to model the observed asymmetries when only the electron population is modified

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References

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Neukirch, T., Vasko, I. Y., Artemyev, A. V., & Allanson, O. (2020), ApJ, 891(1), 86.