

# Competing models for the density fluctuations

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Many thanks to the RPW consortium  
for working on the sc potential data

# RPW electron density measurements

Equilibrium in electric currents

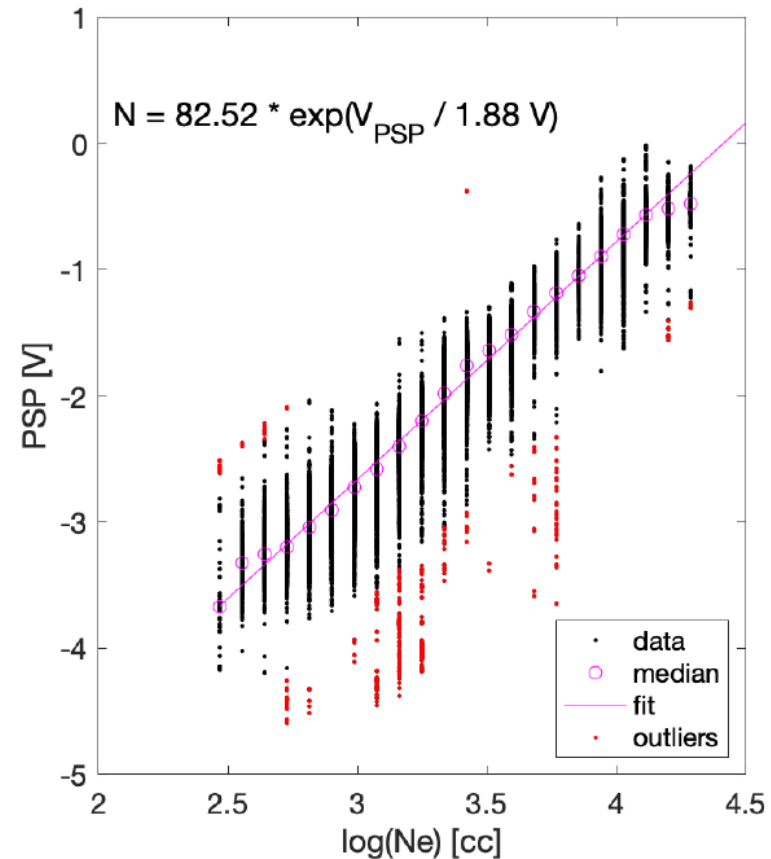
$$I_e + I_{ph} = 0$$

Electron density estimation

$$n_e \simeq N_{RPW} = N_0 \exp\left(\frac{V_{PSP}}{\beta}\right)$$

Electron density can directly be determined from the probe-to-spacecraft potential.

Density data are available as L3 CDF files.

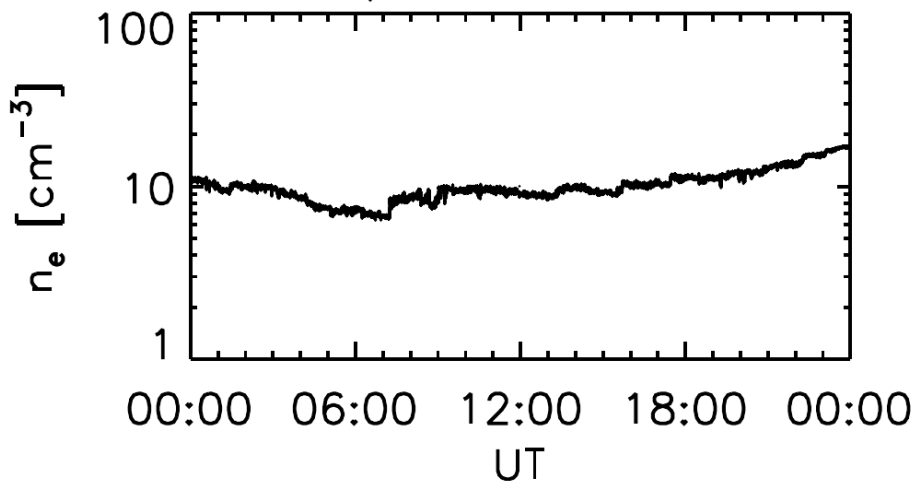


Khotyaintsev et al. (2021)

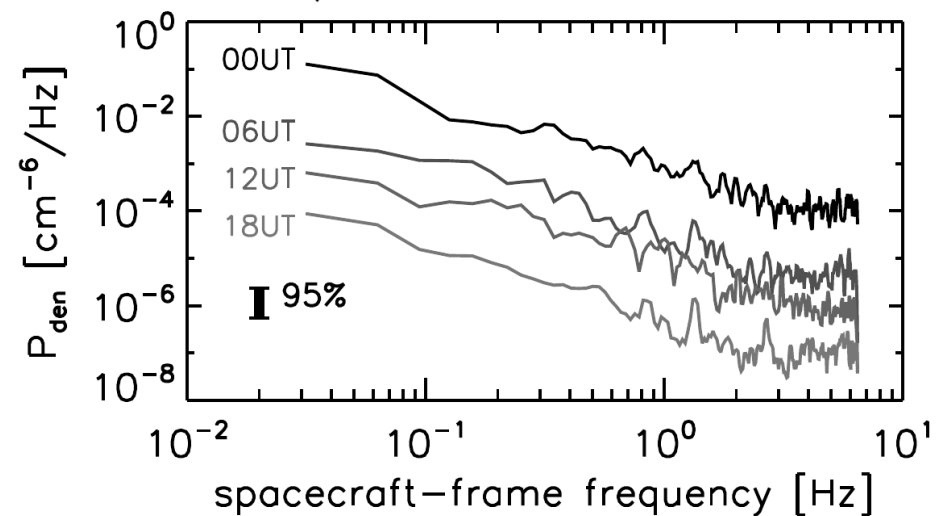
# An example event, October 2020

around first apohelion (1 AU) after the launch

Solar Orbiter RPW  
Electron density  
Oct. 6, 2020



Solar Orbiter RPW  
Electron density spectrum  
Oct. 6, 2020



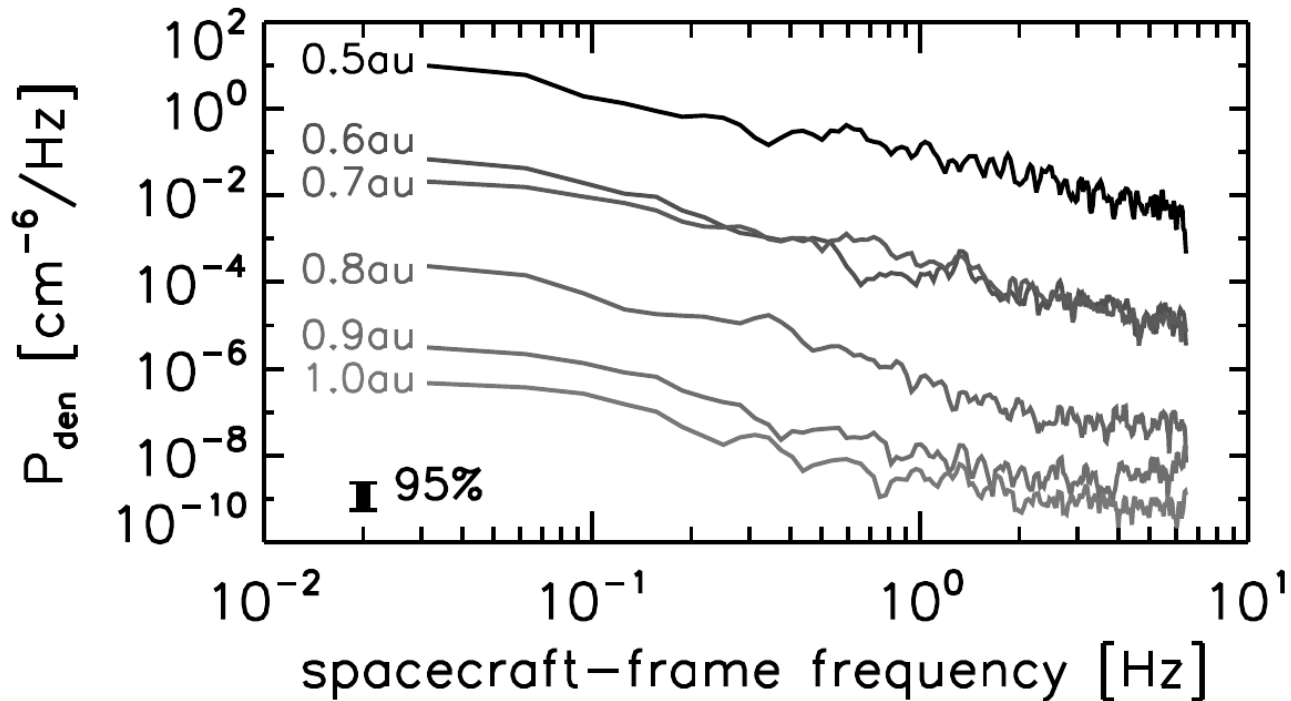
Electron density can be evaluated from the spacecraft potential.

Electron density spectrum becomes flatter around 1–10 Hz... but why?

Question: Are the epoch timestamp in the CDF data in the TT2000 format?

## Radial evolution (outbound, 2020)

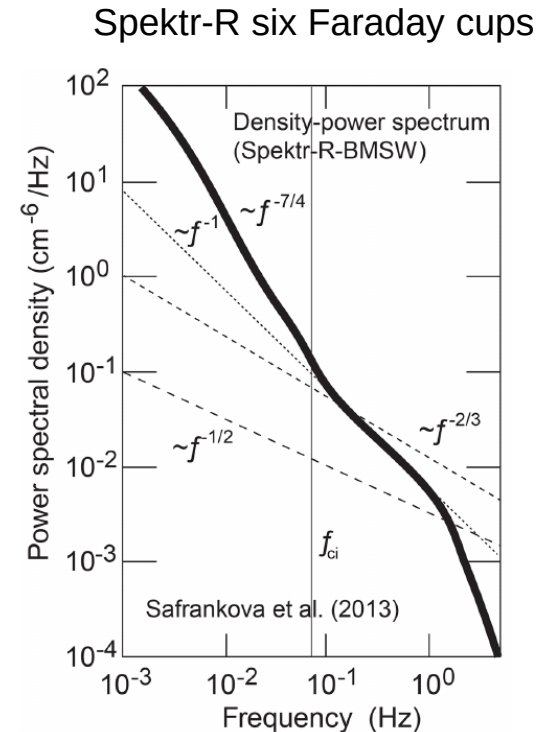
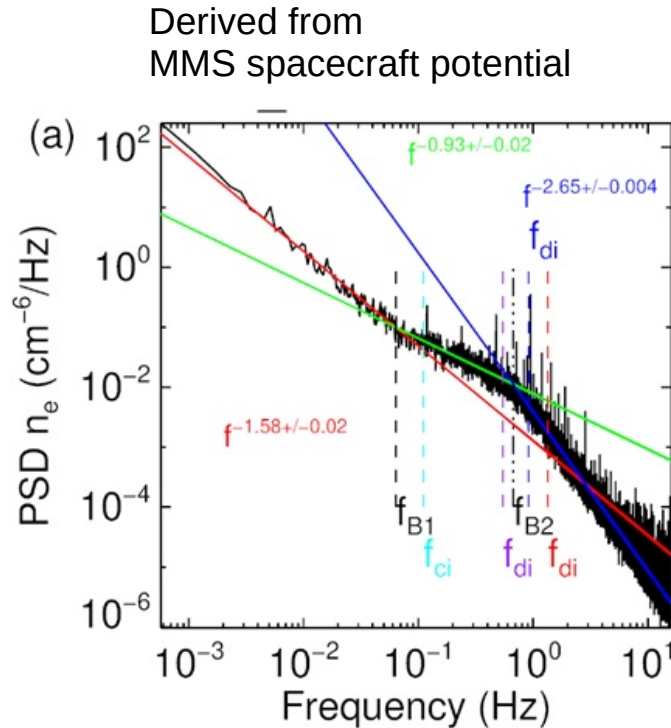
Solar Orbiter RPW  
Electron density spectrum  
Outbound June 2020 – Oct. 2020



Tracking over the radial distances is possible.

Statistical significance? Association with the solar wind condition?

# Lessons from MMS and Spektr-R missions



MMS and Spektr-R data confirm that there is indeed a “bump” in the density spectrum around 1 Hz in the near-Earth solar wind (though not always).

# Competing ideas

Charge separation (Treumann et al. 2019)?

$$i\mathbf{k} \cdot \delta\mathbf{E}_k = \frac{e}{\epsilon_0} \delta N_k$$

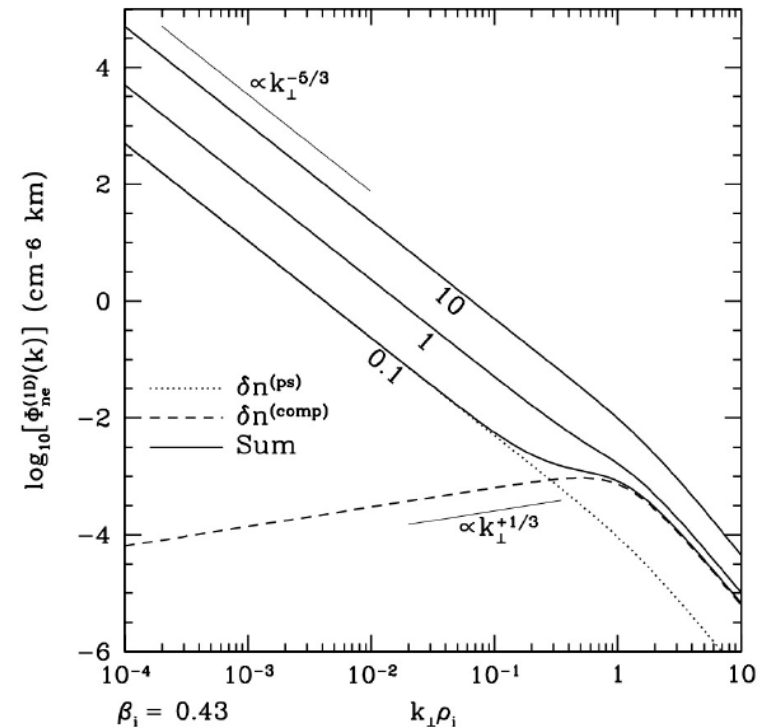
Kinetic Alfvén waves (Chandran et al. 2009)?

$$\left| \frac{\delta n_k}{n_0} \right| = \frac{k_\perp d_i}{(1 + \gamma_i k_\perp^2 \rho_i^2)} \left| \frac{\delta v_{\perp k}}{v_A} \right|$$

More candidates, e.g.,

- linear-mode waves (oblique whistler waves)
- nonlinear waves (quasi-static balance)

Density spectrum expected from KAW waves (Chandran et al., 2009)



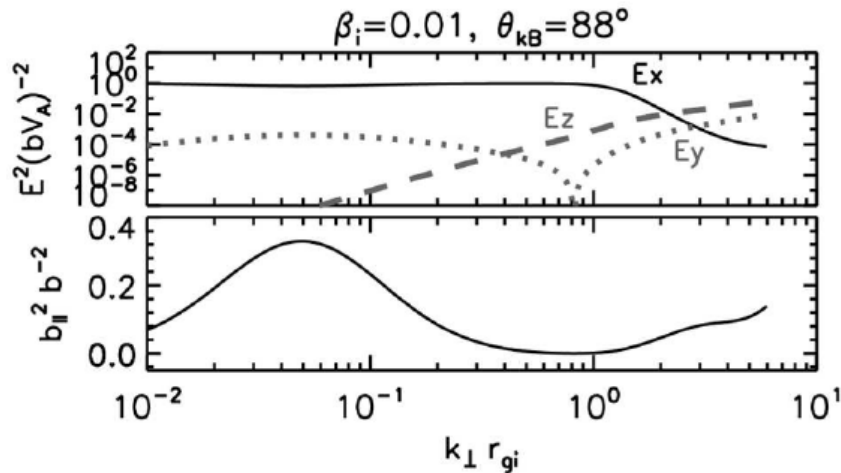
# Analysis methods for RPW data

Are the fluctuations linear-mode waves or something nonlinear?

E-B ratio, Poynting flux, wave distribution func.

Radial evolution from the Sun?

KAW transport ratios (Narita et al., 2020)



E-B ratio for Hall turbulence (Narita et al. 2019)

