ÖAW – AUSTRIAN ACADEMY OF SCIENCES

MULTI-SCALE ANALYSIS OF COMPRESSIVE FLUCTUATIONS IN THE EARTH'S MAGNETOSHEATH

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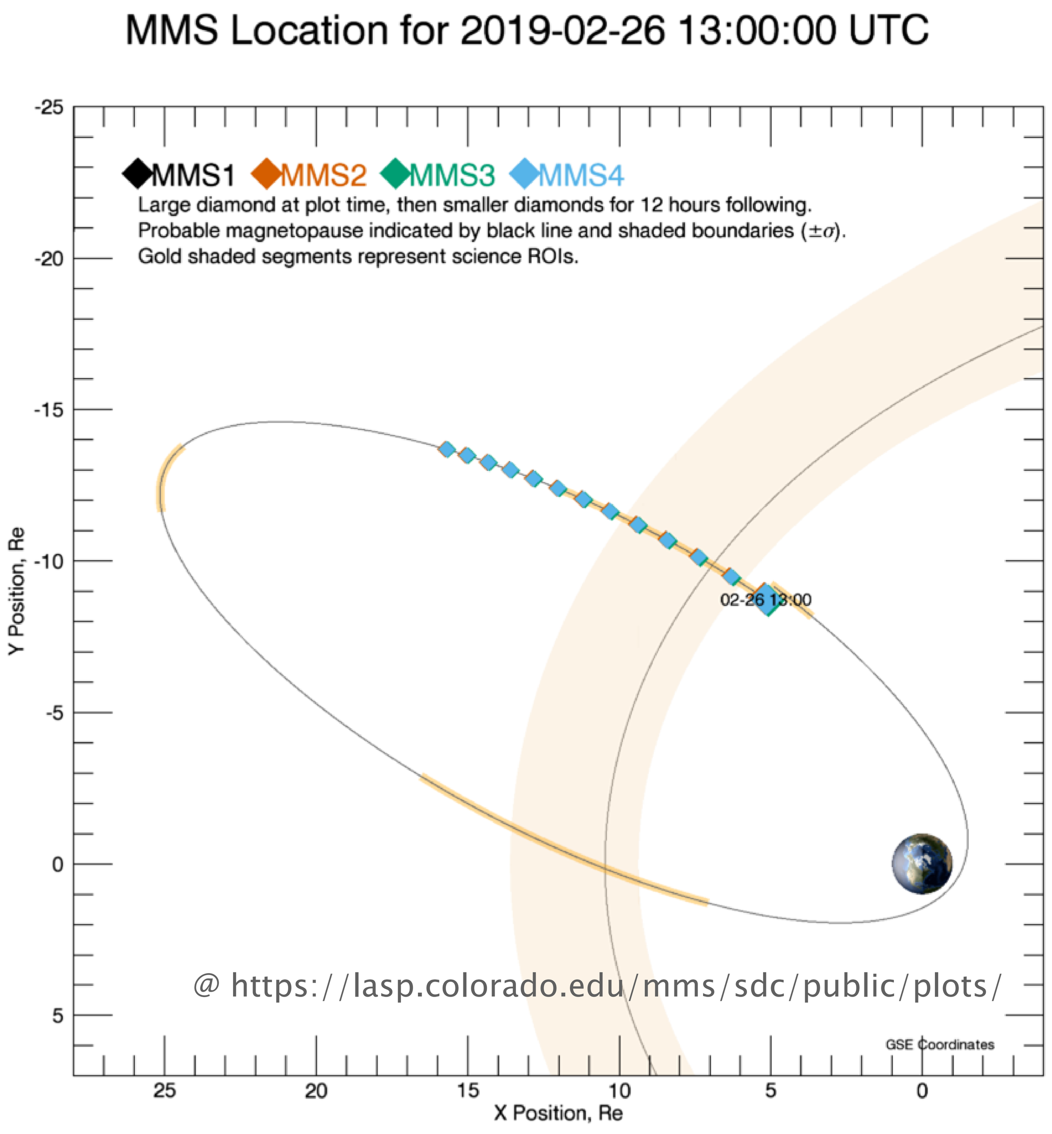
For this analysis, MMS EDP spacecraft potential data was calibrated in intervals where ASPOC was operating and used to derive electron densities as comparison to FPI plasma density measurements.

Moreover, statistical turbulence analysis was performed comparing methods using one or multiple spacecraft measurements.

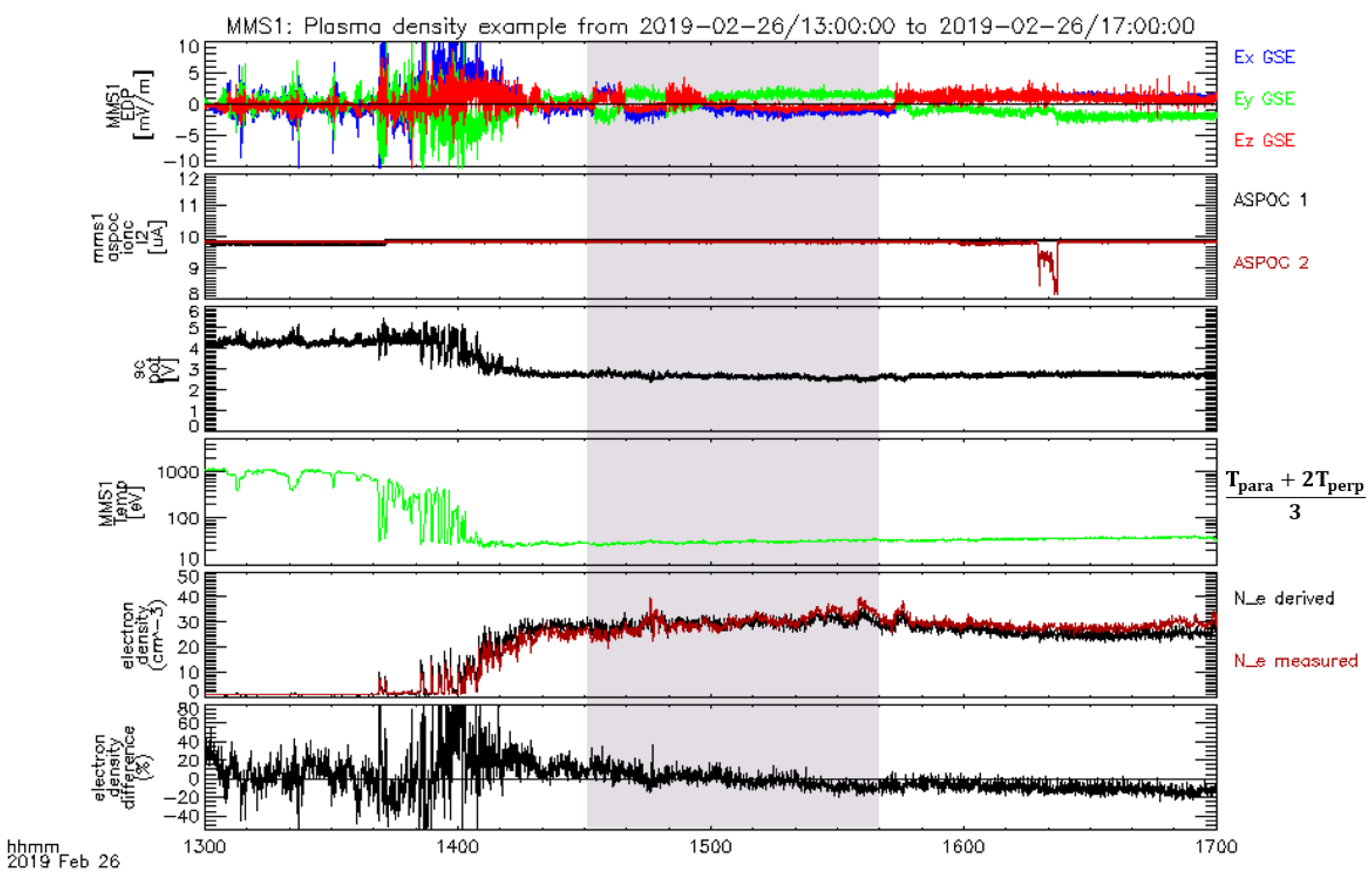
INTRODUCTION

The chosen time interval is part of the MMS Solar Wind Turbulence Campaign (2019-02-26/13:00:00 to 2019-02-26/17:00:00) and hence the 4 s/c were aligned, instead of their nominal tetrahedron constellation. In this time period inter-spacecraft distances range from at least 100 km to almost 1000 km.



For the studies, fast mode data from following instruments was used: EDP (V_{sc}), FPI (T_e, n_e) and ASPOC (I_{ASPOC})

ASPOC instrument was ON for the whole time interval



POTENTIAL CALIBRATION

Simplified current balance equation with ASPOC ON:

$$I_e + I_{ASPOC} + I_{phot} = 0$$

Thermal electron current collected by spacecraft:

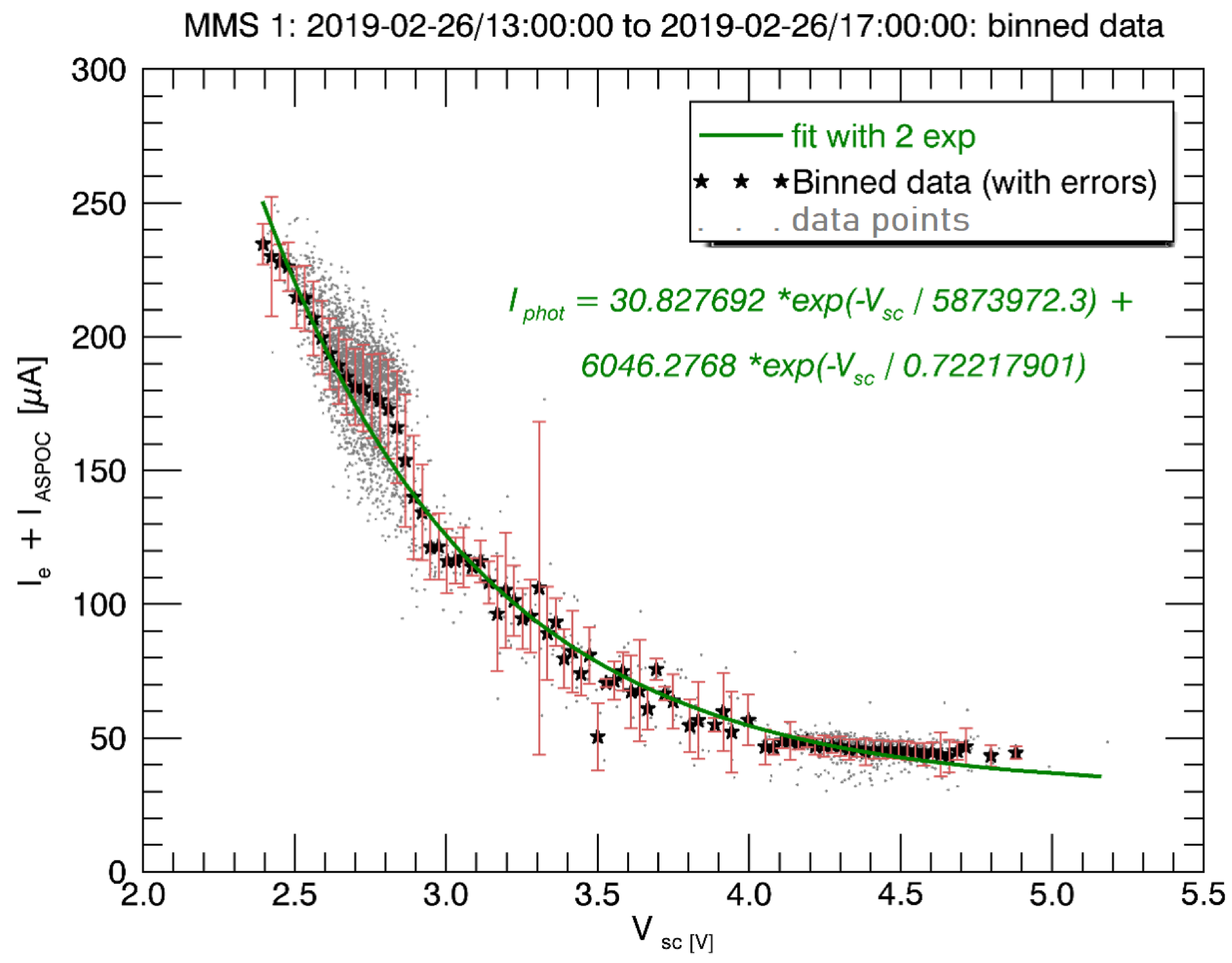
$$I_e = -\frac{A * q}{\sqrt{2 m_e \pi}} * n_e * \sqrt{k_B T_e} \left(1 + \frac{|q| V_{SC}}{k_B T_e}\right)$$

Photoelectron currents away from spacecraft modeled with 2 exp. terms:

$$I_{phot} = I_0 * \exp\left(-\frac{V_{SC}}{V_0}\right) + I_1 * \exp\left(-\frac{V_{SC}}{V_1}\right)$$

In combination with balance equation → electron density:

$$n_e = -\frac{1}{q * A} * \left(\frac{k_B T_e}{2\pi * m_e}\right)^{\frac{1}{2}} * \left(1 + \frac{|q| V_{SC}}{k_B T_e}\right)^{-1} \left[I_{phot} - I_{ASPOC}\right]$$



STATISTICAL TURBULENCE ANALYSIS

- Spin-tone removed s/c potential data from 2019-02-26/14:30 - 15:40
- Computation of V_{sc} increments (single s/c):

$$\delta V_{sc}^{\tau}(t) = V_{sc}(t+\tau) - V_{sc}(t)$$

$$\rightarrow \quad \lambda = v_{ion}\tau \quad \text{(Taylor hypothesis)}$$

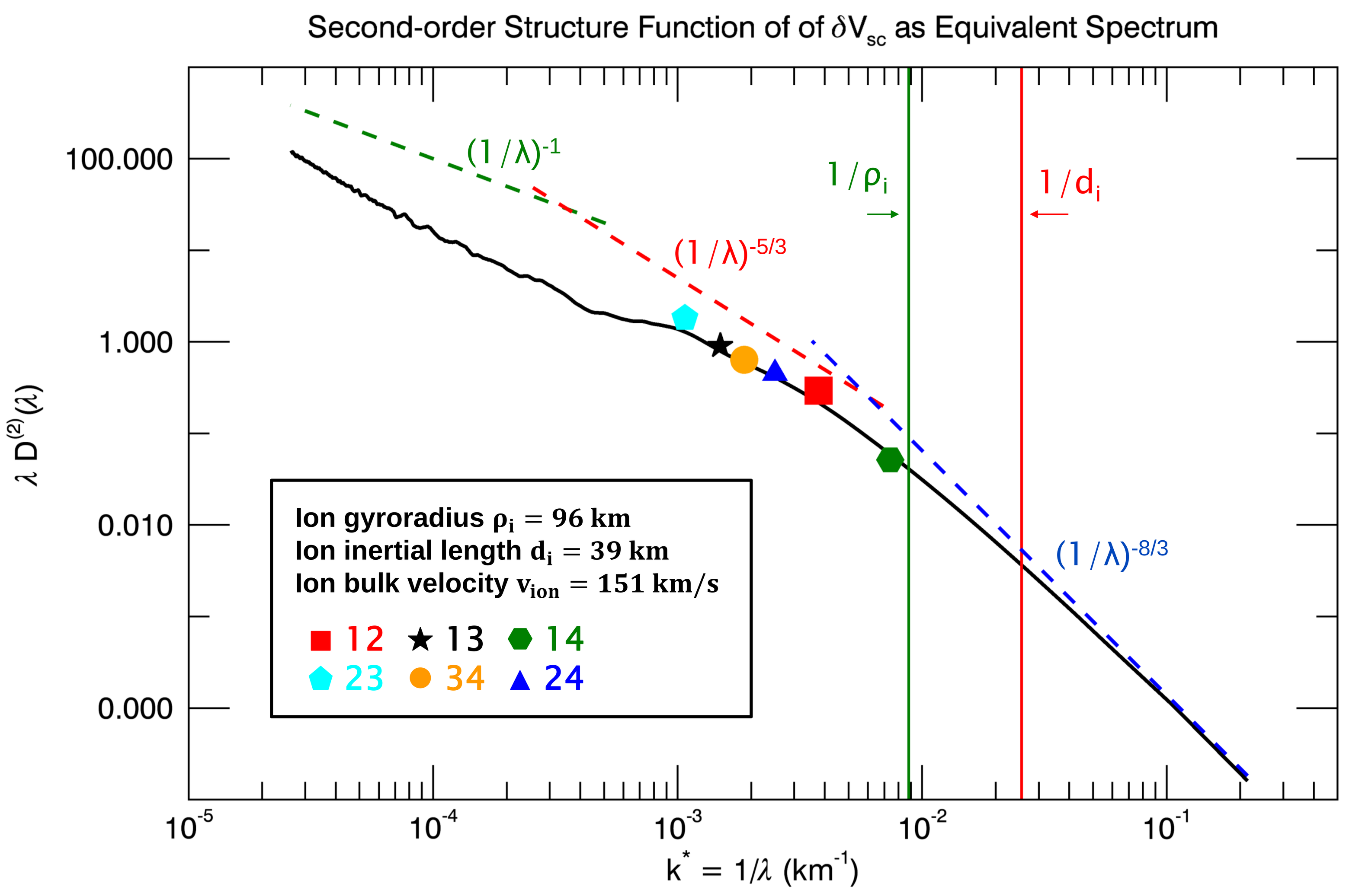
- Computation of V_{sc} increments (multi s/c):

$$\delta V_{sc}^{ab}(t) = V_{sc}^{a}(t) - B_{sc}^{b}(t)$$

- Structure function of order p:

$$D^{(p)}(\tau) = \langle[\delta V_{sc}^{\tau}(t)]^p\rangle$$

The following plot shows the Equivalent Spectrum $D^2\lambda$ for the grey part of the time interval in the overview plot on the left. The x-axis represents the effective wave number $k^* = 1/\lambda$. Filled symbols represent multi-s/c and the black line single s/c (MMS1) time –ag analysis. Similar work has been done e. g. in Chhibber et al. 2018 [1] for magnetic field measurements.



OUTLOOK & SUMMARY

- Potential calibration possible when ASPOC on
- Eq. Spectrum:
  - smaller scales (kinetic range) → steeper slope
  - Taylor hypothesis holds, however spatial lag is not in the same direction as sampling direction
- Longer time series necessary for higher order analysis (e.g. kurtosis), comparison to other time intervals in the magnetosheath
- Comparison of s/c potential fluctuations with magnetic field fluctuations to be done

[1] Chhiber, Rohit, et al. "Higher-order turbulence statistics in the Earth's magnetosheath and the solar wind using Magnetospheric Multiscale observations." *Journal of Geophysical Research: Space Physics* 123.12 (2018): 9941–9954.

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