Key results of the ISSI Team #556 Cross-Scale Energy Transfer in Space Plasmas led by Kieokaew R. & Yang Y. (1/2)

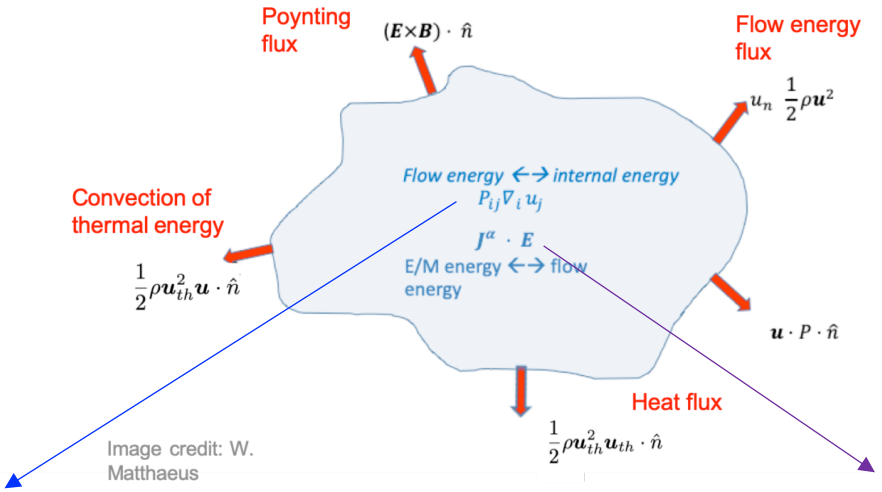
Measuring the energy conversion and transport of plasmas *in situ* allows us to estimate the contribution of different processes. The electric field and the pressure-strain tensor (e.g., Yang, 2019; panel a) are key quantities for estimating energy conversion between forms.

Multi-point, simultaneous measurements are required to estimate these energy conversion proxies. Using four-spacecraft measurements from the Magnetospheric MultiScale (MMS) mission, Roberts et al. (2023) first proposed and investigated the calculation error of the pressure-strain tensor (panel b).

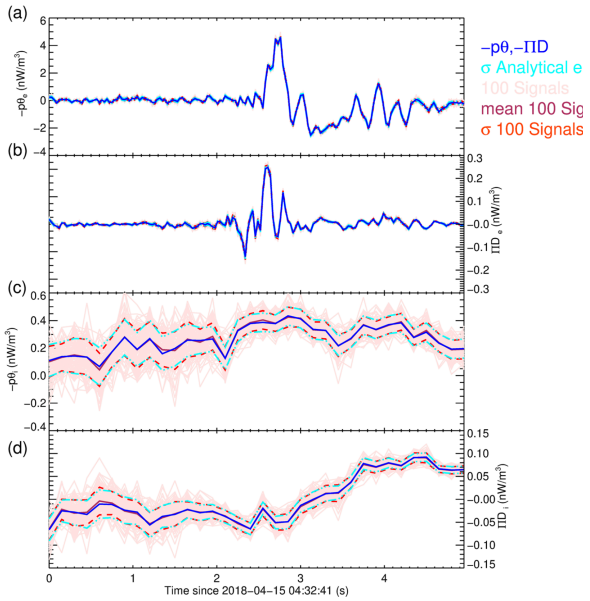
Also using MMS, Lewis et al. (2023) performed a first statistical study to estimate the electric field at different scales (panel c), revealing the new physics of particle energization that could only be studied with a multi-spacecraft constellation.

These two exemplary results highlight the unique capability of multi-spacecraft missions and the care that needs to be taken when using them.

(a) Energy transport and conversions in an arbitrary volume for each species α

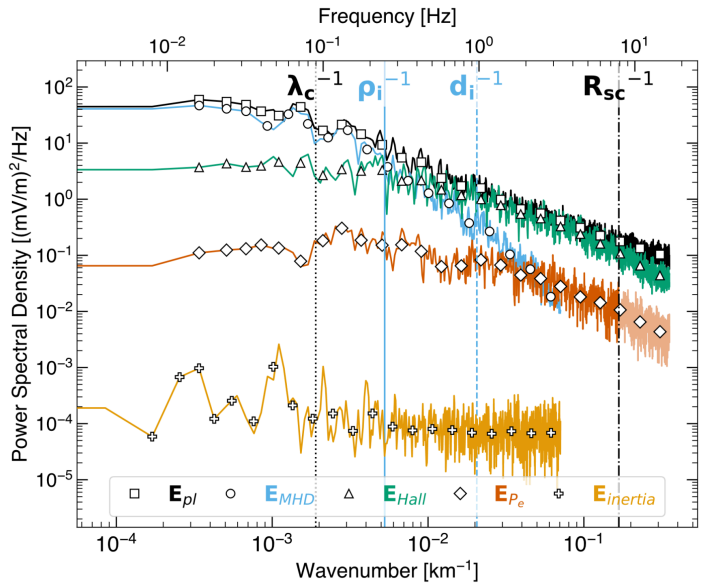


(b) Pressure-strain tensor *(with errors)*



[Roberts et al. 2023; JGR]

(c) Electric field



[Lewis et al. 2023; PoP]

Key results of the ISSI Team #556 Cross-Scale Energy Transfer in Space Plasmas led by Kieokaew R. & Yang Y. (2/2)

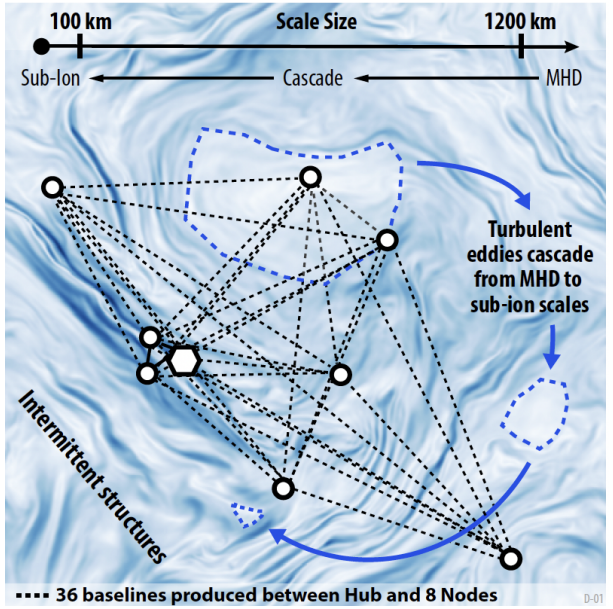
With future cross-scale simultaneous measurements from multi-spacecraft constellations such as HelioSwarm and Plasma Observatory (panels a, b), 3D spatial structures and spatial gradients will become accessible.

Considering arbitrary multi-point measurements, Broeren et al. (2024) revisited the classical linear reconstruction and proposed the novel approaches: the Radial Basis Function (RBF) reconstruction and a time-dependent weighted interpolation scheme called Timesync (panel c). The cross-comparison of the three methods shows that the two new methods outperform the linear approach.

Using 7-point and 9-point measurements in analytically generated fields, Shen et al. (2025) proposed new algorithms to obtain quadratic spatial gradients.

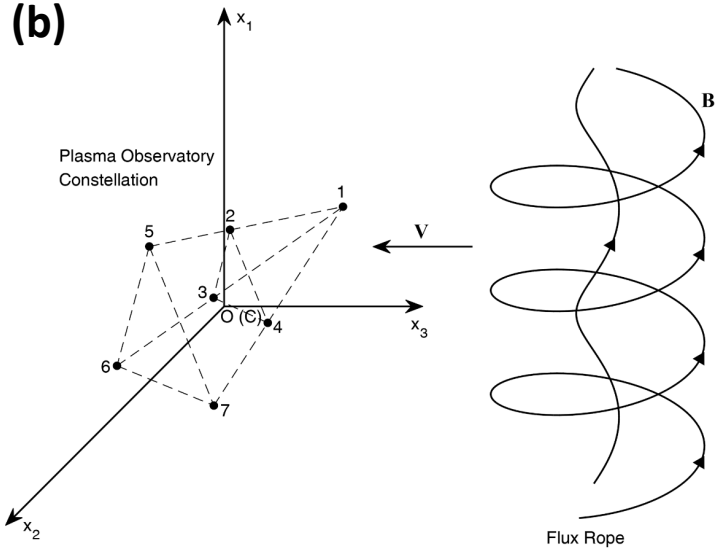
These exemplary works contribute new tools for future data analyses with the multi-spacecraft constellation of HelioSwarm and Plasma Observatory.

(a)



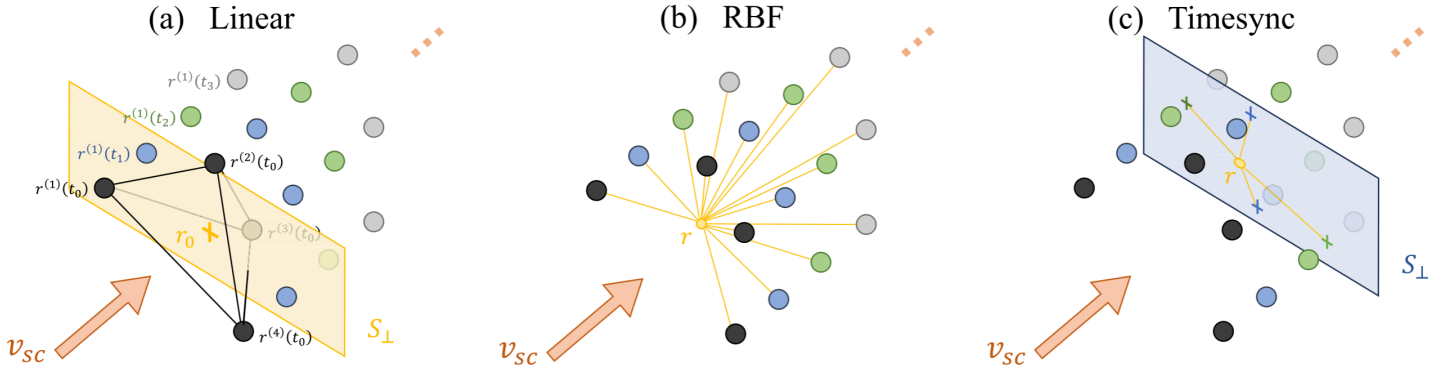
[Klein et al. 2023; SSR]

(b)



[Shen et al. 2025; ANGEO]

(c)



[Broeren et al. 2024; JGR]