A Measure of Alfvénic Turbulence during PSP encounters 6, 7, and 8

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1. Overview

- Alfvénic turbulence is developed by the interaction of inward/outward propogating Alfvén waves.
- *In situ* measurements show predominant preferential outward direction.
- Alfvén cascade cannot devlop without the presence of inward propagating wages.
- Theoretically, $\mathbf{z}^{\pm} = \mathbf{u} \pm \mathbf{v}_A$ where $\mathbf{u}$ and $\mathbf{v}_A = \delta\mathbf{B}/4\pi\rho$ are fluctiations, represent outward/inward Alfvén waves.
- In highly outward Alfvénic flows, $\mathbf{z}^-$ spectrum at low frequency is convected structures, while high end trails off to white noise. (Wang et. al. 2018)
- PSP will probe across the Alfvén critical point.

2. Motivation

- Can we extract out the true power of Alfvén waves?
- What information can we gather at various cross-helicities?

3. Turbulence Tools

- Rectified Elsässer variables:

$$\mathbf{w}^{\pm} = \begin{cases} \mathbf{z}^{\pm} & \text{if sgn}(B_{0r}) = -1 \\ \mathbf{z}^{\mp} & \text{if sgn}(B_{0r}) = 1 \end{cases} \quad (1)$$

- Residual Energy:

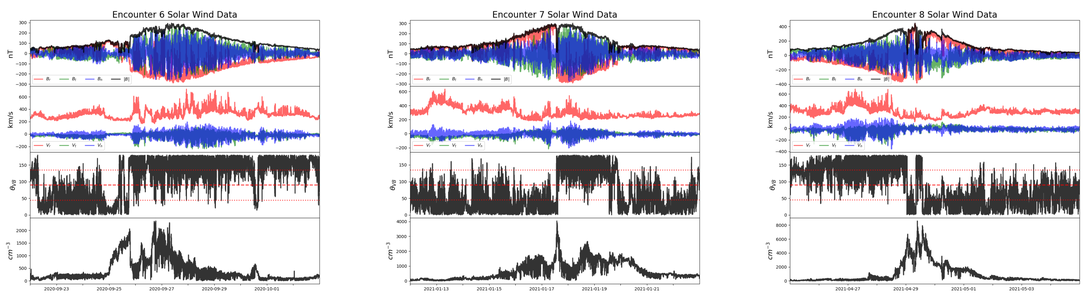
$$\sigma_r = \frac{2\langle \mathbf{z}^+ \cdot \mathbf{z}^- \rangle}{\langle z^{+2} \rangle + \langle z^{-2} \rangle} = \frac{\langle u^2 \rangle - \langle b^2 \rangle}{\langle u^2 \rangle + \langle b^2 \rangle}$$

- Cross Helicity:

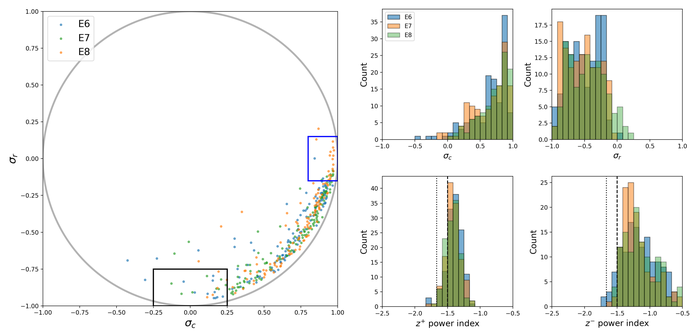
$$\sigma_c = \frac{\langle z^{+2} \rangle - \langle z^{-2} \rangle}{\langle z^{+2} \rangle + \langle z^{-2} \rangle} = \frac{2\langle \mathbf{u} \cdot \mathbf{b} \rangle}{\langle u^2 \rangle + \langle b^2 \rangle}$$

4. Characterizing PSP Encounters 6, 7, and 8

- So what do the bulk properties of PSP Encounters 6, 7, and 8 look like?

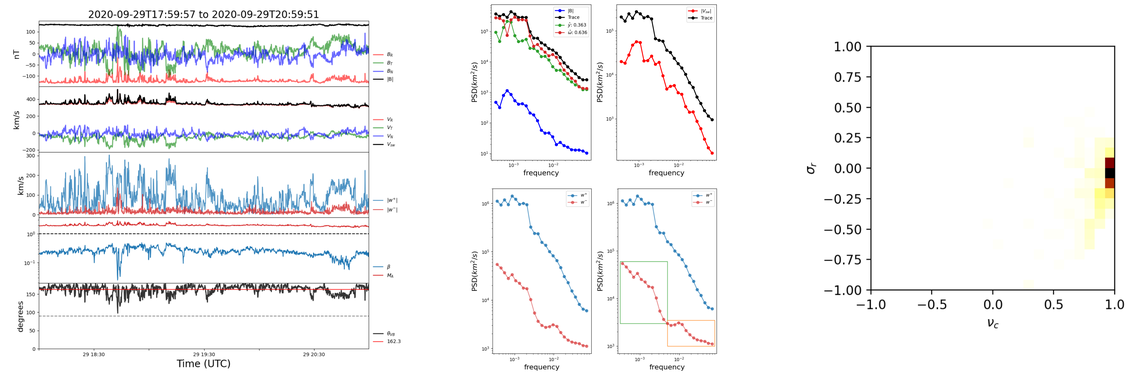


- We can already see that each period is predominately outward Alfvén waves. To see this better we can look at the residual energy and cross-helicity.

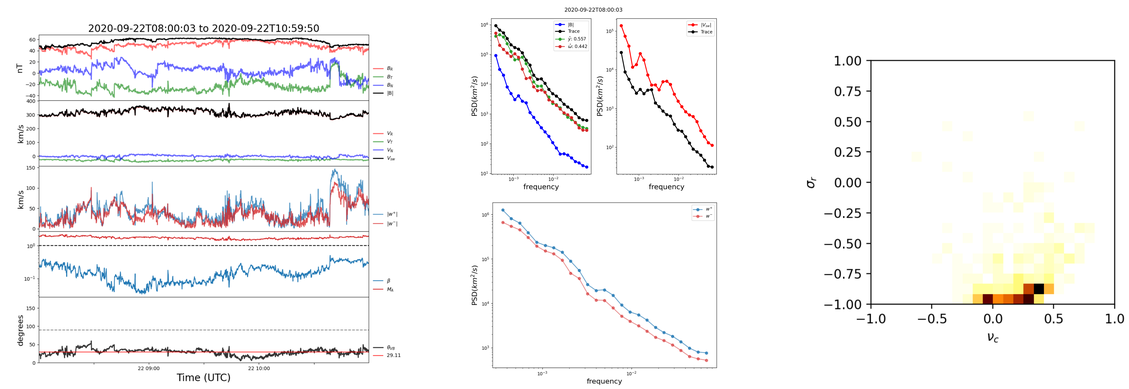


5. Results

- We select periods that are four hours in duration that are highly Alfvénic.



- We find in the highly outward Alfvénic periods, z^- fluctuations give rise to a psuedo-structure and noise spectrum. We then investigate periods with $\sigma_c \sim 0$ and $\sigma_r \sim -1$



6. Summary

- Under the assumption that z^- fluctuations are a super position of low-frequency structures and Alfvén components. We extract the total Alfvén power.
- Using PSP encounters 6, 7, and 8 we see predominately outward Alfvén wave modes. However, $\sigma_c \sim 0$ and $\sigma_r \sim -1$, hint at possible regions of inward and outward wave interactions.
- Periods with $\sigma_c \sim 0$ and $\sigma_r \sim -1$ are complicated by the existence of magnetic structures convected in the solar wind. How can we isolate the total inward Alfvén Power?
- We see total power is perpendicular to the background magnetic field for both the highly Alfvénic and $\sigma_c \sim 0$ and $\sigma_r \sim -1$.

7. Acknowledgment

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8. Contact Information

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