

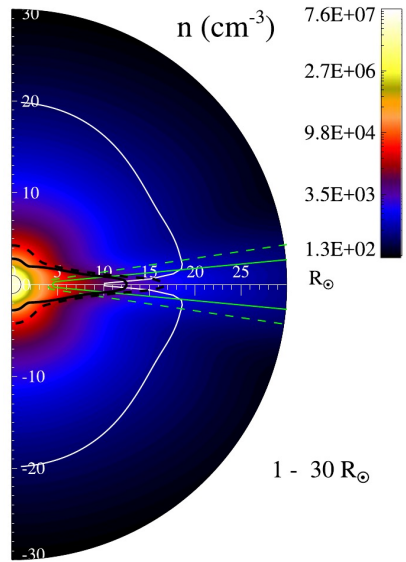
Alfven Zone: a neighborhood where PUNCH  
may observe interesting things happening

W. Matthaeus

PUNCH 2 Science Meeting Aug 10 2021

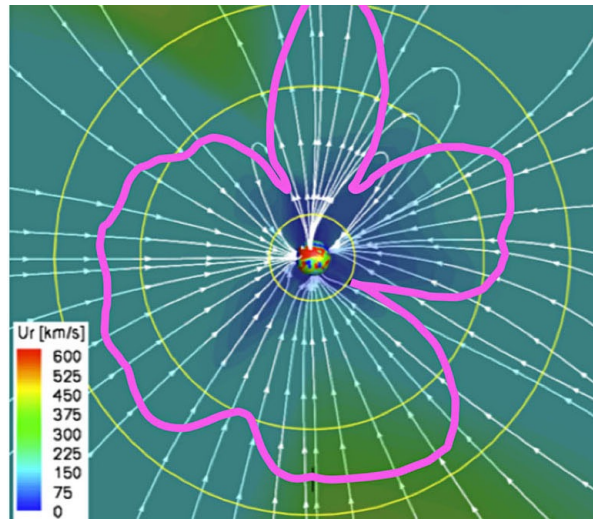
Session 5

### Smooth Alfven Surface



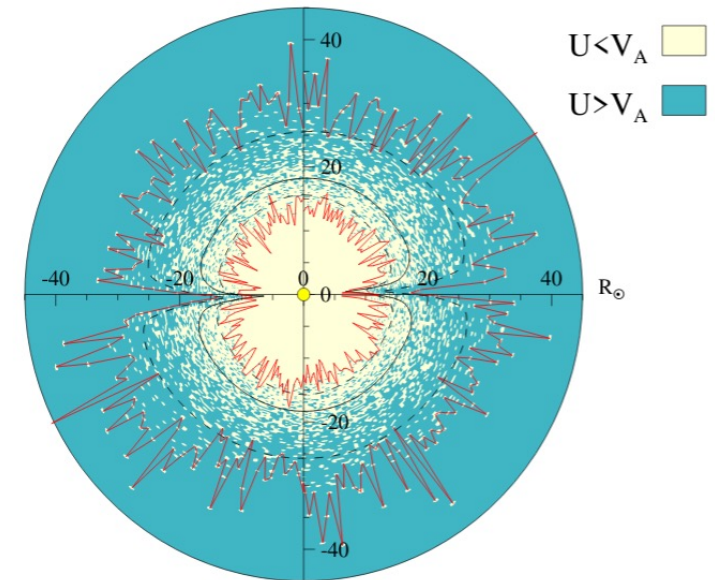
Chhiber+ 2018

### Irregular Alfven Zone



Cohen 2015

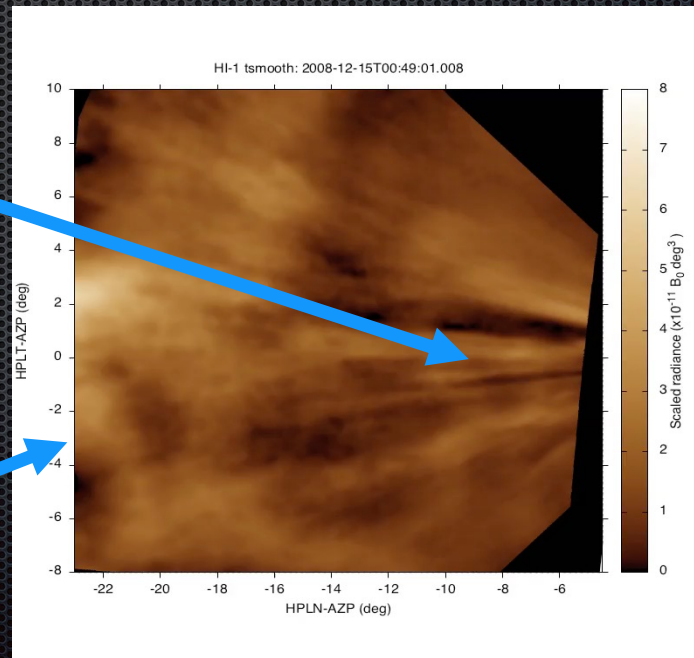
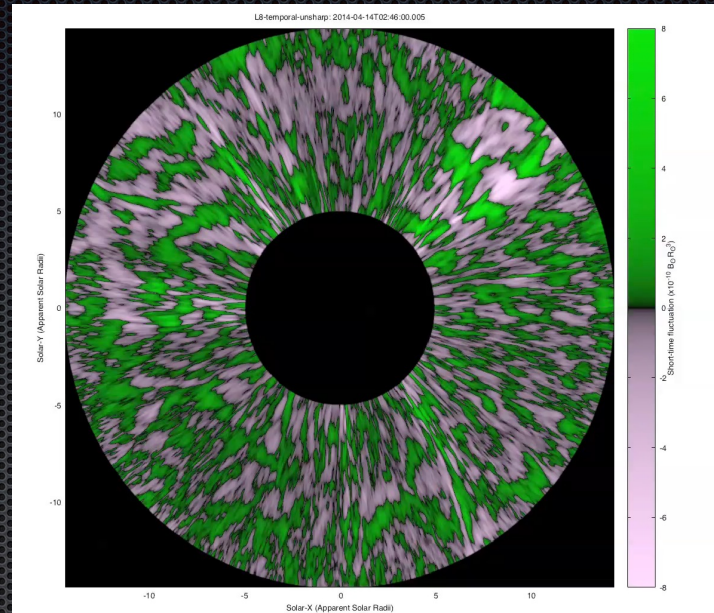
### Corrugated Alfven Zone with "fractal" islands



Chhiber+ 2021

# Solar wind transition outside the ACZ:

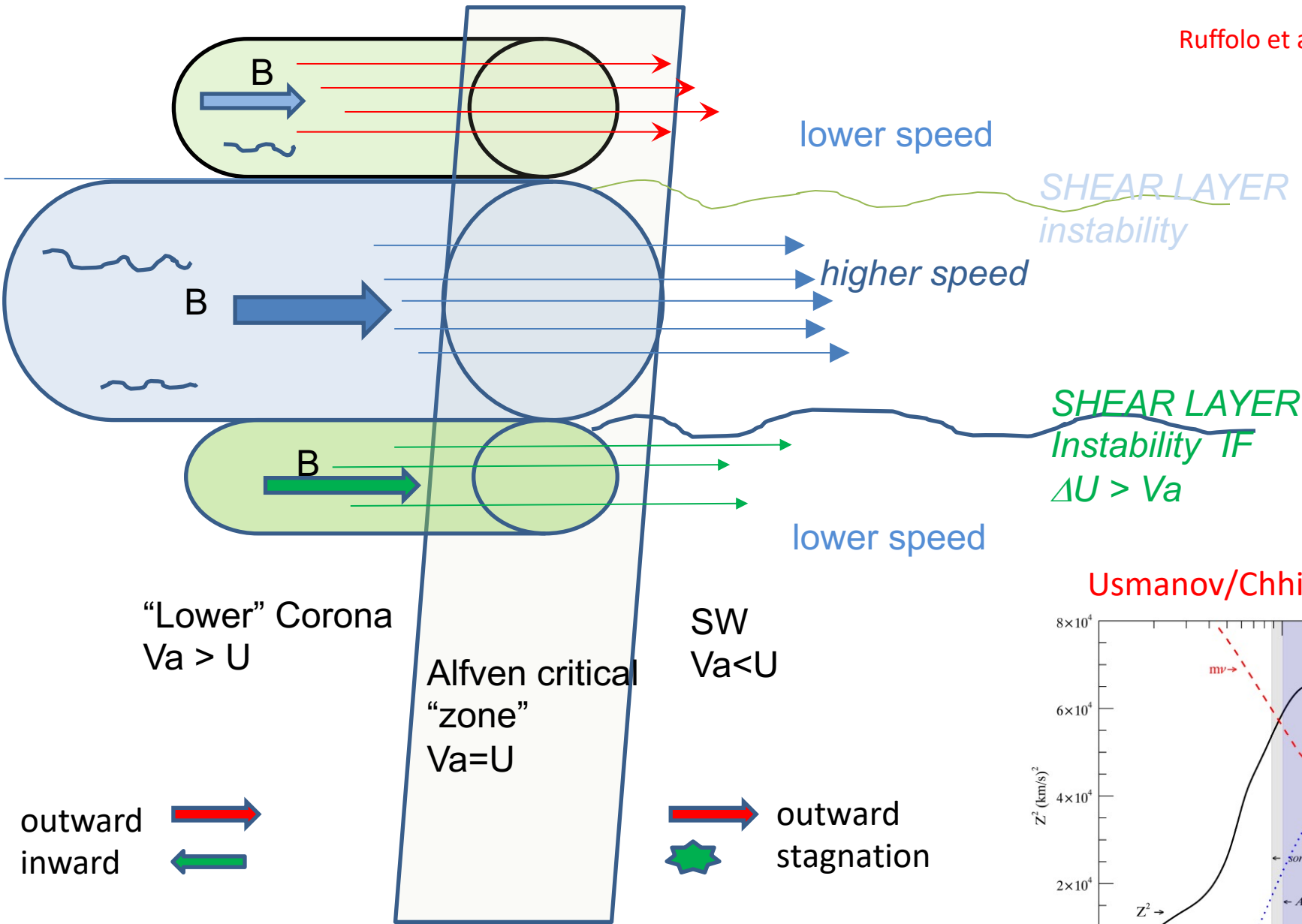
- Coronal structure breaks up.
- Striae break apart
- “focculae” fade in
- Smallest observed features:  $\sim 500$  Mm
  - ( $\sim 3/4 R_s$ )
- Evolution suggests smaller features are present, but unresolved.



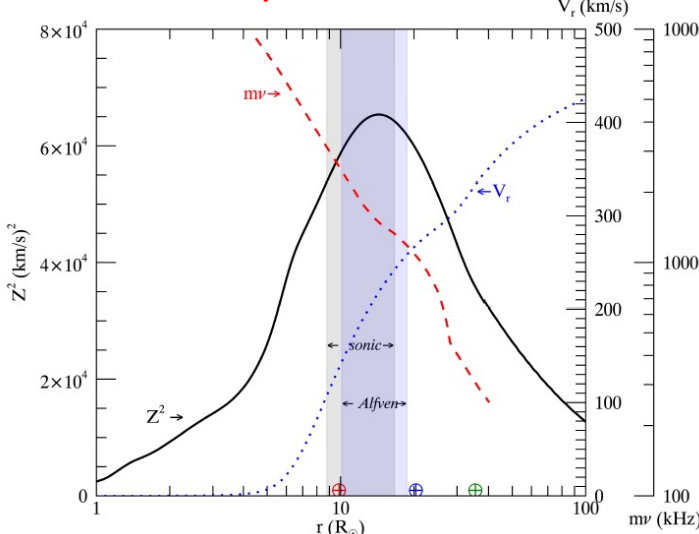
*Striated  
corona*

*Focculated  
solar wind*

**Hypothesis:  
explanation of  
flocculation  
and onset of SW  
turbulence**



**Usmanov/Chhiber simulations**

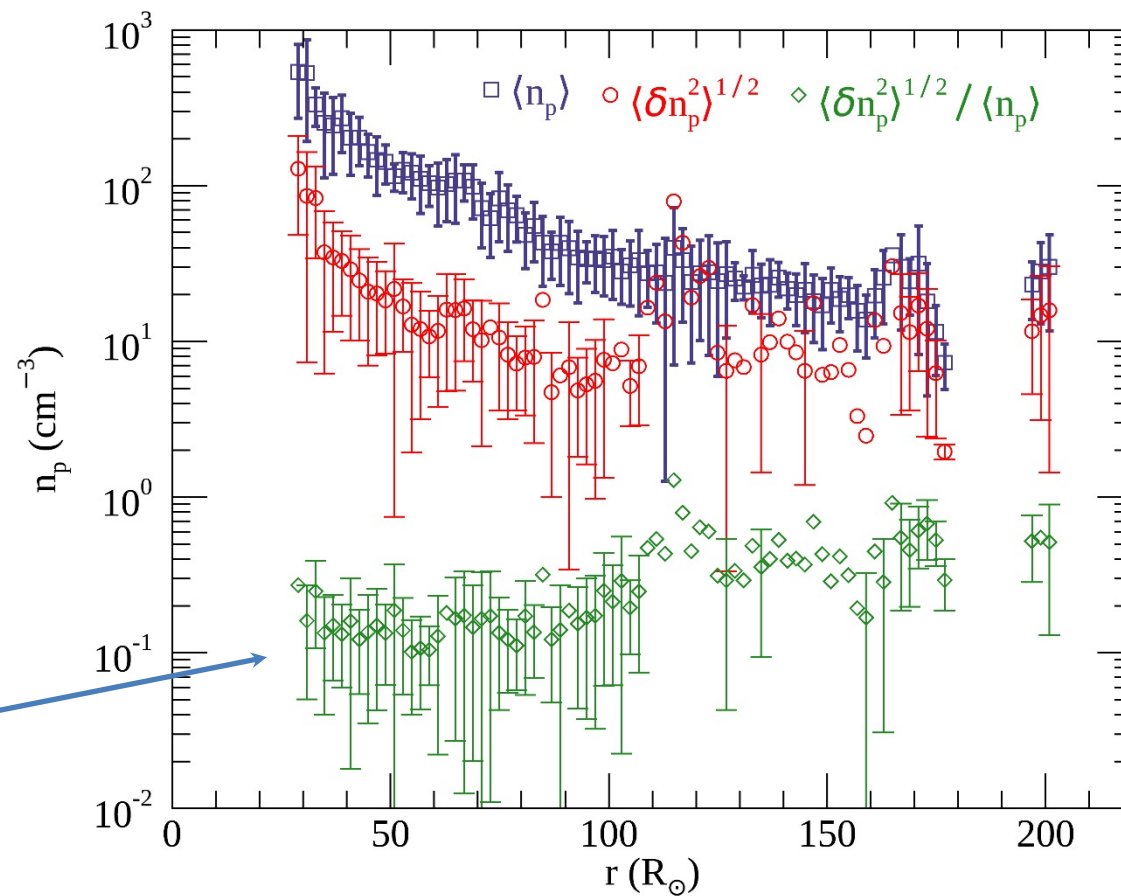


• *mv* fit to remote sensing data  
(Lotova et al. AA 1985)

## More density fluctuations in/near Alfvén Zone?

Averaged over 5 PSP orbits

(Cuesta, Chhiber+ 2021)



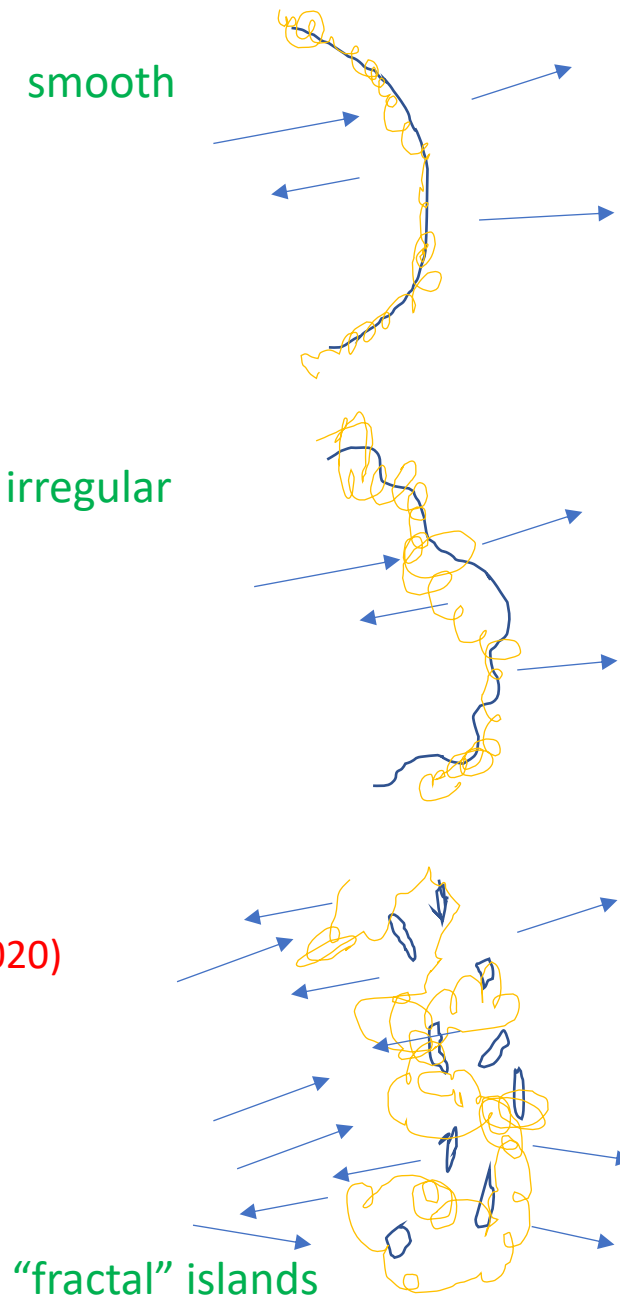
Enhanced density  
Fluctuation level  
may be good for  
PUNCH S/N

## Effects anticipated in/near a “fractal” Alfvén zone

- Stagnation of inward fluctuations  $dZ^-$  (at multiple locations)
- Enhanced
  - turbulence level  $dZ$ ? (“stationary target”)
  - Enhanced reflections (Alfvén speed variations)
  - acceleration? (increased ponderomotive force)
  - density fluctuations? (more turbulence)
  - heating? (more dissipation)
  - particle energization? (more trapping, turbulence e.m.f)
  - energetic particle scattering? (more turbulence)

### Problem of length scales

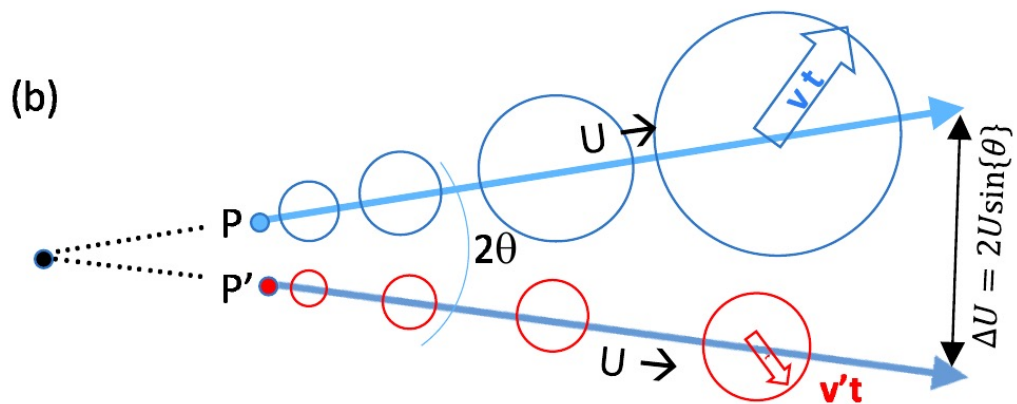
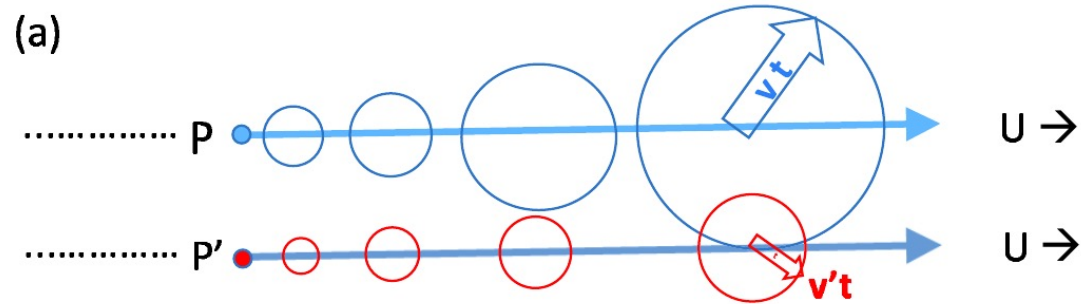
- Radial evolution of parallel vs perp correlation scales:  
inferred from observations (Helios - Ruiz\_ 2012; PSP- Chhiber+ 2021; Cuesta+ 2021; Adhikari+ 2020)
- But what causes this? Does Alfvén zone or KH rollup zone induce a shorter perp correlation scale by injecting energy locally?
- Does Alfvén zone act like a wind tunnel grid?
- Punch can directly address such questions !! For example, might be able to extract perpendicular scales AND parallel scales (PSP is limited)



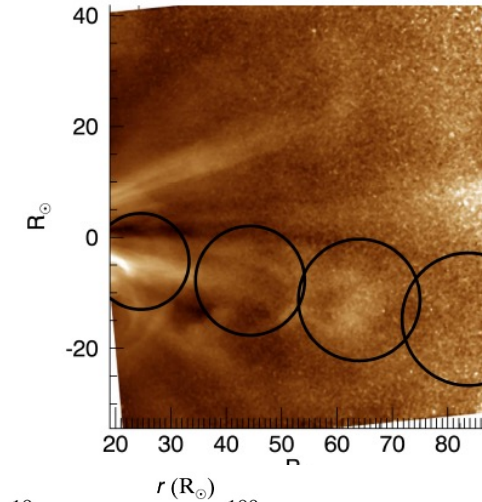
extras

# Factors influencing analysis of interactions OUTSIDE the critical regions (Region of influence/Causality):

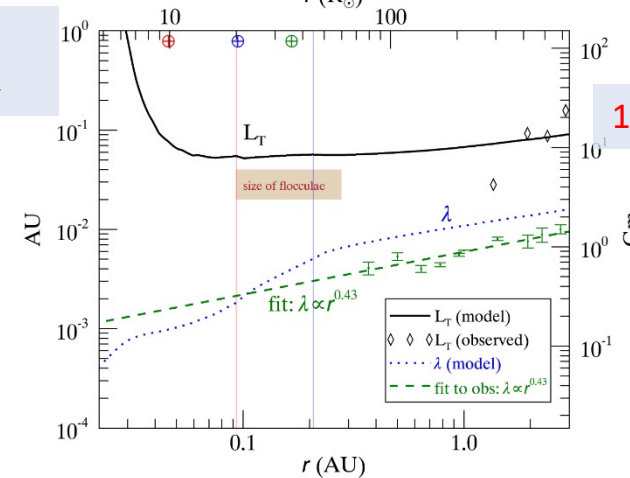
- a) Downstream influence in a uniform flow
- b) Add expansion
- c) what are speeds  $v, v'$  of information spread?



- Flocculae are  $\sim 10x$  larger than extrapolated values of correlation length
- Represent onset of large scale turbulence as the causal region of influence of turbulence increases with  $r$

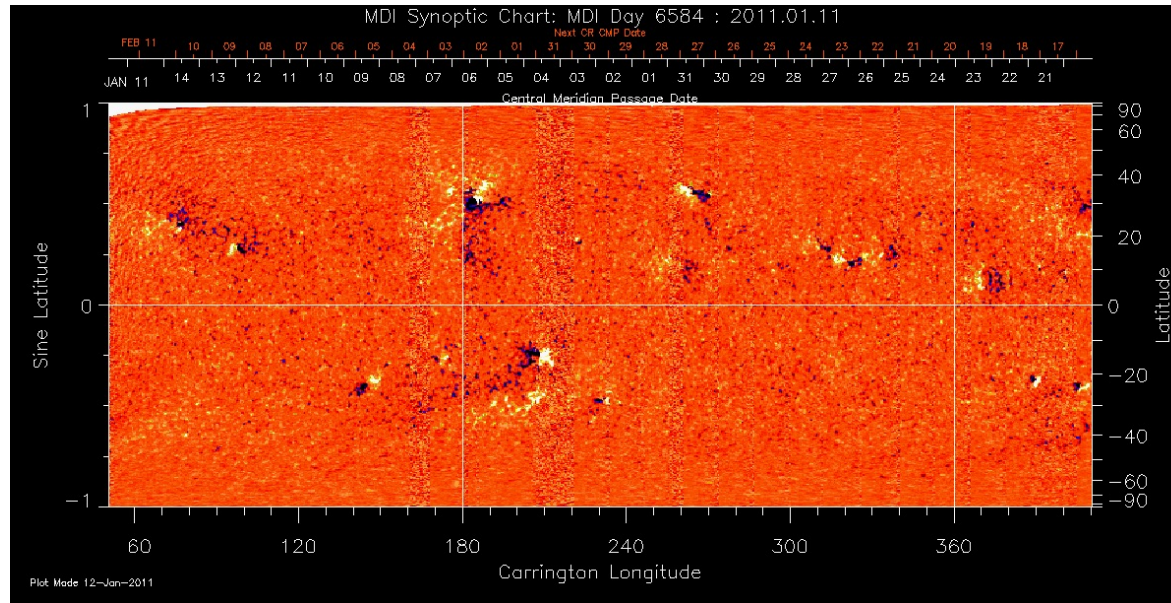


Region of influence  $L_T$



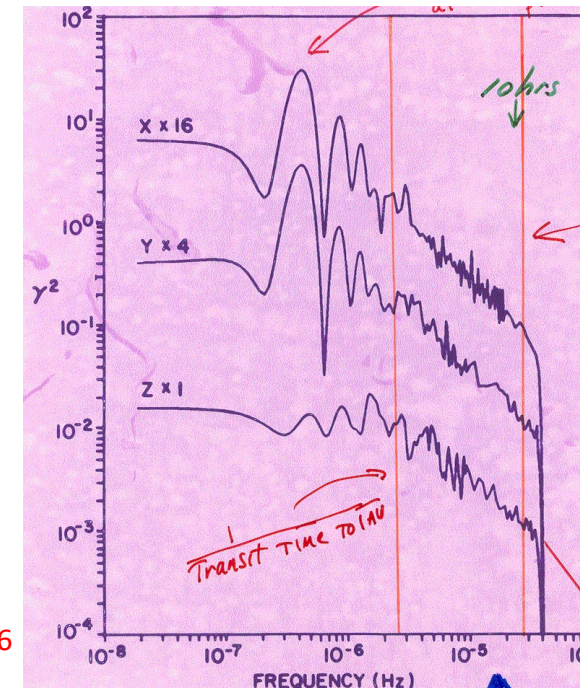


# Inner boundary conditions/largest structures



Largest scale  
Structures:  
magnetograms

$1/f$  noise:  
As observed at 1 AU



WHM & Goldstein, PRL 1986