Big Question

- Recent years have seen work suggesting that turbulence might be an important player in energetic particle dynamics (Zank, T essein, Matthaeus, Trenchi, Ruffollo, Khabarova …)

- We asked the question:
  - "What role does turbulence play in the acceleration and dynamics of Solar Energetic Particles?"

- The main goal was to identify key problems/ questions to refine focus within this broad area.
Turbulence & Shocks

- Two focus areas emerged
  - Do we have signatures of turbulence in SEP observations?
  - Can (heliospheric) shocks drive turbulence behind them?
Examples of shocks without upstream waves

\[ \Theta_{Bn} = 74^\circ \quad \Theta_{Bn} = 73^\circ \quad \Theta_{Bn} = 66^\circ \]
\[ M_A = 2.6 \quad M_A = 1.1 \quad M_A = 2.9 \]
• Lack of waves upstream of most shocks at 1AU indicates a lack of flux at lower energies of EPs.
• This lack might mean that there is not enough turbulence to take core/lower tail particles from the distributions and energize them.
• Shock simply reprocesses higher energy EPs.
  – BUT... the shocks are already weak. Maybe they did process some population earlier?
Questions/Suggestions

- Do upstream waves always have to be present to indicate turbulent energization?
  - Can we find examples?

- Upstream waves are very important in the energization dynamics because they can trap particles for long enough.

- Look at abundances of heavy ions as well to address some of the local energization vs. transport issues.
Could be energized by turbulence 
Or could be particles trapped in a flux tube 

Compare energization level to existing predictions e.g. Matthaeus et. al. PRL 84?
This quantity is large when oppositely directed fields are close together.

\[ L_c \nabla \times \frac{B}{B_0} \]

\[ M_A = 5 \]

\[ M_A = 1000 \]

\[ M_S = 5 \]

\[ \langle \theta_{Bn} \rangle = 90 \]
Question/ Suggestions

- Could the particles from lower ends of non-thermal tails be participating in shock heating?
- Heliospheric shocks likely do not enhance existing turbulence and hence likely do not enhance the possibility of that turbulence energizing the particles.