Suprathermal Tails in Solar Wind Fe and O

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Suprathermal Tails in H & He

- High speed tails have been observed in solar wind H\(^+\) and He\(^{++}\), as well as in pickup He\(^+\) (Gloeckler, Gloeckler & Mason).
- Tails have implications for particle injection into the shock acceleration process.
- Investigate heavy ion speeds; characterize possible tails in ions heavier than He.

- Using STEREOPLASTIC:
  - Obtain the energy spectrum of O and Fe from periods of high and low speed solar wind

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Suprathermal Tails in H & He

Fisk & Gloeckler, 2007

• Spectral index is:
  ✓ -1.5 for differential energy spectra
  ✓ -5 for spectra plotted as a distribution function in velocity space.

• Model uses:
  – stochastic acceleration
  – compressional turbulence
  – thermal isolation (needed to form the constant spectra).

• There is no dissipation of turbulence which would cause a net increase in the energy of the particles - turbulence just transfers energy from low energy core to tail.

• The highest energy particles develop gyro radii that exceed the scale sizes of the compressions, and:
  – no longer become accelerated, and
  – leave the acceleration region. These escape particles take energy away - the model assumes this is a negligible part.
STEREO/PLASTIC
Heavy Ion Measurements

- Energy range:
  - 0.3 - 78 keV/e one-minute cadence sweep
- Selection: E/q
- Measurements:
  - Time of Flight,
  - Residual Energy (SSD)
- All ions are counted and classified (priority rates)
- Sample pulse height events are brought down
- Identify ions by pulse height
- Obtain ion-specific rates by combining pulse height count with priority rates

![Graph showing ion distribution](image-url)
Solar Wind Ions: Essd vs. TOF

- Ion species may be separated by plotting $E_{ssd}$ vs. Time of Flight.
- Each element forms a characteristic trail, regardless of charge state and energy.
Fast and Slow S/W Selection

• Select examples of fast and slow solar wind
• Obtain the energy spectrum of Fe and O
• Three days
  – Fast:
    • 2008/007 ($<V_{sw}> = 621$ km/s)
  – Slow:
    • 2007/340 (Dec 6)
    • 2007/341 ($<V_{sw} = 305$ km/s)
• Get counts/energy step
• Use Q state to get counts/speed step
Fe for Fast and Slow S/W Periods

Low Speed

2007/340
2.8-3.0 keV/eVsw
Vsw = 305 km/s

High Speed

2008/007
16.2-17.9 keV/eVsw
Vsw = 621 km/s
Fe and O counts vs. Energy/charge

- We have spectra in energy/charge
- Now extract ionic charge states and get energy from energy/charge…
• Average charge states shown for each ESA step range: Q(E).
• Charge state tends to decrease with increasing energy.
• Use charge state and ESA step energy to provide average energy.

O

Q vs. E/charge

Fe

Q vs. E/charge
• Fe and O counts/keV vs. S/W speed ratio shown
• Variations are apparent in intensity rollover near peak
• High speed O tends to fall off faster than low speed O.
• Rollover is broader in high speed Fe.
Summary

• The energy spectra of solar wind O and Fe have been calculated for low and high speed periods.
• Both O and Fe count spectra display tails above the H+ solar wind speed.
• Spectral variation appears to take place in both ion species
  – Variations are apparent in intensity rollover near peak; rollover is broader in fast solar wind Fe example.
  – High speed O tends to fall off faster than low speed O.
• Next steps:
  – Energy spectra need to be extended to $>2V_H$ … combine more days to improve statistics.
  – Instrument efficiencies will be applied to convert counts to fluxes
  – Transfer results to solar wind frame.