WG3 Session#1 **Sources of Suprathermal Ions in the Solar Corona**
Monday PM: **and the Interplanetary Medium**

Suprathermal tails provide the seed population for CME-driven shocks, but its properties are not well known.

Critical issue for CME/SEP models LWS and Exploration Initiative

- **What are the main sources of ions in the suprathermal tail?**
- **How do the relative contributions of these sources vary in time and space?**
- **What causes these variations?**
- **How do these variations affect CME-related ESP and SEP events?**
- **What measurements and theoretical studies are needed to make further progress?**

Invited Speakers:

- **Matthew Hill**, *University of Maryland*
- **George Ho**, *APL*
- **Thomas Zurbuchen**, *University of Michigan*
- **Nathan Schwadron**, *Southwest Research Institute*
- **Lennard Fisk**, *University of Michigan*

WG3 Session#1 **Sources of Suprathermal Ions in the Solar Corona and the Interplanetary Medium**

Monday PM:

- **Zurbuchen et al**
- **Analyzed composition of slow, fast, and disturbed/CME-related solar wind**
    1. **Slow solar wind has stronger suprathermal tails and its composition is much more variable than the fast wind**
    2. **Disturbed or CME-related solar wind has higher freezing-in temperature and shows stronger FIP effect**
    3. **Smooth transition between Low and High FIP elements in the solar wind; however, SEPs show a step between low and High FIP elements**
    4. **Presence of suprathermals not enough for a shock to accelerate particles**

WG3 Session#1 **Sources of Suprathermal Ions in the Solar Corona and the Interplanetary Medium**

Monday PM:

- **Hill et al:**
- **Analyzed suprathermal ion composition of 4 CME-driven IP shocks when Cassini was at 1.3 AU, 3.7 AU, 6.7 AU and 8.7 AU**
    - **At ~10 keV/n the He+/He++ ratio near ~1.3 AU was ~0.5, and increased to ~10 in the remaining events**
    - **Pickup ions are a dominant source of material for CME-driven shocks beyond Earth orbit**

Why does the pickup ion contribution not continue to increase as Cassini moves further out?

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- **Ho et al:**
- **Surveyed spectral properties of ~190 CME-driven IP shocks at ACE**
    - **Only ~63% of the shocks accelerated ions above ~50 keV**
    - **Spectral indices do not agree with predictions of simple 1D steady state theory**
    - **Shocks with higher speeds are typically associated with larger ESP events, but one-to-one correlations between particle properties and shock parameters are generally poor**
    - **Ion spectra are well-correlated with "ambient" ion spectra preceding the shocks,**
    - **Results are difficult to reconcile with simple shock acceleration models that inject a mono-energetic stable solar wind population as the seed**

WG3 Session#1 **Sources of Suprathermal Ions in the Solar Corona and the Interplanetary Medium**

Monday PM:

- **Schwadron & Desai**
- **Discussed the theoretical aspects of why the suprathermal ions are favored over the more numerous solar wind ions during injection and acceleration at shocks.**
    - **Injection becomes more efficient at ~1.5-2 times the solar wind speed**
    - **Abundance of pickup He+ at a CIR and a CME-driven IP shock during different periods of the solar cycle was ~15%**
- **Statistical acceleration/transit-time damping could produce suprathermal tails in the interplanetary medium with He+ abundance that remains constant beyond 5 AU**
- **Application of solar wind scaling law indicates that low-energy or thermal plasma remains bound while suprathermals can escape**

WG3 Session#1 **Sources of Suprathermal Ions in the Solar Corona and the Interplanetary Medium**

Monday PM:

- **Fisk: Diffusion of magnetic field lines on the Sun**
  - **distributes open flux and heats/accelerates the solar wind**
  - **Accelerates particles in flares and produce suprathermal tails in the corona**
- **Derived a new transport equation for energetic particles**
- **Statistical acceleration occurs continuously on coronal loops**
  - **Impulsive flares occur when loop is disrupted due to reconnection with open field lines**
  - **Predicts the observed Q/A dependence of heavy and ultra-heavy ion enhancements in 3He-rich flares**
  - **Can also produce power-law suprathermal tails without compositional enhancements that could serve as a seed population for CME-driven shocks**