Outstanding Issues

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&
The SPD Summer School
Faculty and Students
Origin of Flares

• What active region evolution precedes flares and coronal mass ejections?
• What is the relationship between flares and filament eruptions?
• What is the relationship between flares and coronal mass ejections?
Flare Intensity Distribution

- Does the distribution continue to lower intensities with the -1.8 power-law index?
- What is and what determines the highest “intensity” flare?
- Is coronal heating dominated by “nanoflares”?
Flare Morphology

- Do single-loop flares exist?
- Do all flare loops or arcades have the cusp structure?
- Do the basic features of the “standard model” apply to all flares?
- Is the “magnetic breakout” model valid?
- Is multipolar magnetic structure necessary for flares?
Energetic Particles I

• Exactly where are energetic particles injected into the flaring region?
• What is the highest particle energy in each flare?
• What are the lowest particle energies in each flare?
• What is the angular distribution of the particles?
Energetic Particles II

• How are the energetic particles “seen” in microwaves related to those “seen” in hard X-rays?
• How can electron and ion produced sources be in different locations?
• What is the exciter of white light flares?
Energetic Particles III – Gamma Ray Results

- Relationship of impulsive SEPs and particles producing flare X-ray and gamma-ray emission.
- Energy content of the low-energy (<1 MeV) ions
- Composition (heavy element and $^3$He enhancements) of the accelerated particles producing flare gamma-ray emission.
- Understanding the high-density (>10$^{13}$ cm$^{-3}$)-high-temperature (>10$^5$ K) environment implied by the positron annihilation line observations.
- Explanation for how the coronal-like high-FIP enhancements implied by gamma-ray line observations can already be present at chromospheric densities.
Particle Acceleration

• Is there one dominant particle acceleration mechanism? If so, what is it?
• Is particle acceleration confined to a region high in the corona, or is it more distributed?
• What is the efficiency of particle acceleration?
Flare Energetics

• What is the relative amount of energy injected directly into plasma heating vs. particle acceleration?
• What is the relative amount of energy injected into electrons vs. ions?
• What is the relative amount of energy injected directly into cooler plasma vs. “hot” plasma?
• What is the relative amount of energy contained in the flare vs. the CME
• What is the total magnetic energy released in each flare?
Coronal Mass Ejections

• Are there reliable precursors? Can we predict CMEs?
• How are CMEs initiated and why?
• How do CMEs affect the large-scale corona?
• What is the relationship between CMEs, flares, and filaments?
• What is the 3-D structure of CMEs?
• Where do shocks develop?
Outstanding SEP issues

• What is the seed population for large SEP events?
  – does the composition depend on energy?
  – what are the relative contributions of solar wind, coronal, and flare material?

• Do flare particles escape large flaring regions when associated with large/fast CMEs and if so, how?

• Do perpendicular shocks have a higher injection threshold energy than parallel shocks?

• How low in the corona can CME-driven shocks form and accelerate particles?
  – to what energies?
  – over what time scales?

• What does the energy dependent charge states in impulsive events mean?
  – in terms of seed population for flare acceleration
  – in terms of stripping in the corona
  – in terms of where the acceleration is taking place
Outstanding SEP Issues

• Why do so many interplanetary shocks not accelerate particles?

• What is the flare acceleration mechanism and can it explain the high enhancements of ultra-heavy ions in impulsive events?

• What does the different spectral shapes of $^3$He in impulsive events tell us?
  – about the acceleration process
  – about the transport process