Galactic cosmic ray transport in the heliosphere

Thursday, August 2\textsuperscript{nd}, 9:45

**Scene-setting speakers:** J. Giacalone (UA/LPL), N. Schwadron (UNH)

**Conveners:** C. Corti, V. Bindi (UHM)

The goal of this session is to bring together people from various branches of heliospheric science to discuss what can we learn from solar modulation of GCRs (especially above 100 MeV/n) about the small-scale turbulence in the solar wind (diffusion coefficient), the large-scale structure of the solar wind/magnetic field, and how do solar wind disturbances affect GCRs.

Topics of interest are:
- Constraining the HMF turbulence from data beyond 1 AU (Ulysses, Voyagers, interplanetary scintillation, etc).
- Progress in magnetic turbulence theory for diffusion and drift processes in the heliosphere: analytical calculations, MHD & PIC simulations.
- In-situ measurements of disturbances (ICMEs, GMIRs, etc) throughout the heliosphere (SOHO, LASCO, MAVEN, New Horizons, Voyager 2, etc).
- Role of CMEs and GMIRs on short-term (days to weeks) and long-term (months) modulation of cosmic rays.
Radiation Spectrum

- Solar wind
- SEPs, CIRs, etc.
- GCR

Energy/nucleon [MeV/nuc]

Particles/cm$^2$ sr s MeV/nuc

Data sources:
- Mewaldt et al., 2001
- Simpson, 1983
- Ave et al., 2009

O directional intensity
Solar modulation of GCRs
Some questions about the transport coefficients

• Do we really understand charged-particle diffusion coefficients?
  • Perhaps we understand parallel diffusion better (do we?), but how well do we understand perpendicular transport?
• Is quasi-linear theory a reasonable guide?
Some questions about the transport coefficients

- Do we understand how they are related to the turbulent magnetic field?
Some questions about the transport coefficients

- Is it sufficient (in GCR modeling) to assume $\kappa_\parallel \propto 1/B$ and $\kappa_\perp / \kappa_\parallel$ is a constant, which is common.

Assuming the largest events are due to acceleration by shocks, and that diffusive shock acceleration theory applies, the intensity at the highest energies depends on both the shock speed and diffusion coefficient (which depends on the field strength).

(figure courtesy D. Mewaldt)
p/He time dependence

Velocity effect in the diffusion coefficient? Waiting for p/C by AMS...
Local or global effect? Look also at Voyager 2 in heliosheath...

Published on PRL on August 1, 2018 – Data available in SPDF in next days.

*Doi:10.1103/PhysRevLett.121.051101*
Forbush decrease at different locations

Strange solar cycle(s)?

Are we going toward a grand-minimum of solar activity?

Open Flux Depletion
Conclusions and outlooks

• First GCR session at SHINE

• People interested in the topic

• Next year session proposals:
  • Local vs Global effects
  • Voyager 2, IBEX and 1 AU comparisons
  • Time dependence of p/He and p/C: challenges for theorists