Contribution ID: **727** Type: **Talk**

A study of variations of galactic cosmic ray intensity based on a hybrid data-processing method

Friday 16 July 2021 19:18 (12 minutes)

The low energy cosmic-ray (CR) fluxes measured by space-borne instruments are
generally considered to consist of the gradually changing galactic cosmic rays
(GCRs) and the short-lived solar energetic particles (SEPs). The SEP events cause the sharp and ephemeral increases in the time profile of CR observations with higher occurrence rate in solar maximum. It is necessary to eliminate such
spikes and obtain the pure GCR component while studying the modulation of GCRs
both in short and long time scales. A hybrid data processing method based on
spike detection and time series analysis techniques is developed to remove
the spikes and decompose the GCR data observed by the Interplanetary Monitoring
Platform 8 (IMP 8) into the long-term variation trend and the 27-day variation components. With the hybrid data processing method, the 11-year
and 27-day variations in the intensity of low energy GCR can be studied
systematically. Using the fitted trend component, the time lag in solar modulation of low energy GCRs is studied, and the results show that the time lag is both epoch and energy dependent. The obtained 27-day variation component is anti-correlated with the changes in solar wind velocity even during solar maximum. Implementing the running Fourier series fit procedure, the 27-day
variation amplitude of proton flux is computed. It is found that the yearly averaged values show clearly 11- and 22-year variation cycles. In addition,
the energy spectrum of the 27-day variation amplitude is softer in $A < 0$ solar minimum than that in $A > 0$ solar minimum.

Keywords

Collaboration

other Collaboration

Subcategory

Theoretical Results

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Session Classification: Discussion

Track Classification: Scientific Field: SH | Solar & Heliospheric