Solar-Planetary Relationships: Cosmic Rays

rotational-symmetric around the instantaneous magnetic field direction, it is a function of a single variable, the pitch angle, and can be written as a Fourier series. It is shown here that there is a linear relation between the solar wind coefficients and the set of sector counting rates. It can therefore be expressed by a matrix. The matrix elements depend on the number of sectors, the opening cone of the detector telescope, the angle between spin axis and the magnetic field direction, and the angle between spin axis and detector axis. This expression is a linear form of the maximum obtainable number of Fourier coefficients and their corresponding coefficients.

In the interplanetary medium the Compton getting effects of pitch angle distribution makes pitch angle distributions appear rotationally symmetric. A reduction of this effect is also possible using matrix rotation.

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**SC 17**

PITCH ANGLE DISTRIBUTIONS OF CHARGED PARTICLES IN INTERPLANETARY SPACE MEASURED ON HELIOS DURING A SOLAR EVENT

G. Wibberenz, West Germany

For a solar event of rather simple structure observed by HELIOS, charged particle data of the two interplanetary space experiment were analysed by the method described by Green in his presentation. The magnetic field direction in the observed event was determined up to the fourth harmonic, the influence of the magnetic field vector on the field direction of the interplanetary magnetic field is negligible. The magnetic field vector is determined by the interplanetary magnetic field at the observation point and its direction is given by the magnetic field vector at the observation point. The magnetic field direction is given by the magnetic field vector at the observation point and its direction is determined by the magnetic field vector at the observation point.

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**SC 20**

THE INTERPLANETARY SHOCK WAVE EVENT ON NOV. 19, 1975 OBSERVED BY HELIOS-A AND IMP-7,8

E. Kepper (Max-Planck-Institut, Lindau, FRG)
S. T. Barrow (APL/JHU, Laurel, Maryland)
S. M. Krimigis (APL/JHU, Laurel, Maryland)

In studying the interplanetary acceleration of energetic particles, i.e., shock-spikes and in particular the acceleration region, there is a need to distinguish the short-term (few minutes) intensive acceleration region from the long-term (days) process of acceleration in the interplanetary medium which involves the long-time effects on the particle population. The acceleration region is given by the particle population with an energy-dependent acceleration rate. The observed signatures of the energetic particle event on November 19, 1975, are discussed.

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**SC 21**

ACCELERATION OF ENERGETIC PARTICLES BY SHOCK WAVES

E. Leer, G. Skorren (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, FRG)
W. I. Axford (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, West Germany)

The problem of acceleration of energetic particles by shock waves propagating in a scattering medium has been considered by Fish in his discussion of energetic particle events and shock waves. In this work we add some additional comments concerning steady state solutions and energy spectra of general form. In addition, we discuss the situation in which the particle density is sufficient to affect the background density. The results are of interest with regard to the term of the acceleration of low energy cosmic rays in corotating interaction regions. The mechanism of shock wave propagation and reverse shock waves which arise must be separated on the basis of the contact surface in the vicinity of the reverse shock. The observed signatures of the energetic particles associated with this interaction region provide clear evidence for the adiabatic deceleration of particles which must result from such an expansion.

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**SC 22**

A SIMILARITY THEORY FOR ENERGETIC PARTICLE ENHANCEMENTS ASSOCIATED WITH INTERPLANETARY SHOCK WAVES

G. Skokron (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, West Germany)
W. I. Axford (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, West Germany)

It is assumed that a spherically symmetric, forward-reverse shock pair propagates radially through a quiet-day solar wind containing a spherically symmetric distribution of low energy cosmic rays. The cosmic rays are allowed to pass, without reflection, from the unshocked to the shocked solar wind. Using a solar wind velocity profile for strong shocks a similarity solution for the diffusion of cosmic ray number density, valid for a general ambient cosmic ray spectrum, is formulated. For the case in which $V_0 (V)$ is a power law and $\alpha = 0$, it is found that (1) similarity solutions exist only for a small range of $\alpha$, and (2) the cosmic ray amplification at the forward shock is large for ambient spectra near the critical energy $E_c$. It is the spectral index of $V_0$ which is 2.5, the cosmic ray density falls off with $V_0$ as $V_0^{-4}$, and the shock becomes small in the vicinity of the contact surface, and (4) the cosmic ray density in the vicinity of the reverse shock is qualitatively similar, producing a steady-state diffusion coefficient profile across the shock pair.

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**SC 23**

PERSISTENT SUNWARD FLOW OF 1.6 MEV PROTONS AT 1 AU

E. F. Marshall
E. C. Stone (both at: Dept. of Physics, Calif. Inst. of Technology, Pasadena, Calif.)
S. M. Krimigis (APL/JHU, Laurel, Maryland)
G. Wibberenz (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, FRG)
W. I. Axford (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, West Germany)

The anisotropy of 1.3 to 2.3 MeV protons has been measured with the Galileo Electrons/Isotope Spectrometer aboard IMP-7 for periods between prompt solar particle events from July 27 to July 28. The direction of this flow has been computed by subtracting the independently determined cosine of the angle between the observed anisotropy and the solar wind vector. The direction of this flow is parallel to the solar wind vector, and indicates that the solar wind is slightly deflected by the magnetic field of the Sun. The direction of this flow is parallel to the solar wind vector, and indicates that the solar wind is slightly deflected by the magnetic field of the Sun.

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**SC 24**

A STEADY-STATE MODEL OF SUNWARD FLOW OF LOW ENERGIES PROTONS

E. C. Stone
E. F. Marshall (both at: Dept. of Physics, Calif. Inst. of Technology, Pasadena, Calif.)
S. M. Krimigis (APL/JHU, Laurel, Maryland)
G. Wibberenz (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, FRG)
W. I. Axford (Max-Planck-Institut für Aeronomie, 3414 Katlenburg-Lindau, West Germany)

The steady-state flow of solar protons observed on IMP-7 has been modeled as a steady-state injection function. The propagation of these particles is computed using a series solution to the Poisson-Planck equation, which includes diffusion and anisotropic energy loss. The solution has been obtained by assuming (1) an adiabatic symmetry, (2) $\alpha$, independent of energy and radius, (3) no injection of particles, $r < r_1$, and (4) a finite density of particles for $r > r_1$, and then calculating the expected density for $r > r_1$. The calculated density distribution is expected to be strongly dependent on $r$ but only weakly dependent on $E$. The solar wind velocity profile for strong shocks is a similarity solution for the diffusion of solar cosmic ray number density, valid for a general ambient solar cosmic ray spectrum, is formulated. For the case in which $V_0 (V)$ is a power law and $\alpha = 0$, it is found that (1) similarity solutions exist only for a small range of $\alpha$, and (2) the cosmic ray amplification at the forward shock is large for ambient spectra near the critical energy $E_c$. It is the spectral index of $V_0$ which is 2.5, the cosmic ray density falls off with $V_0$ as $V_0^{-4}$, and the shock becomes small in the vicinity of the contact surface, and (4) the cosmic ray density in the vicinity of the reverse shock is qualitatively similar, producing a steady-state diffusion coefficient profile across the shock pair.
dependent on $v_{m}$. Using the mean observed spectral index $-3.15$ and the mean solar wind speed of 440 km/sec, the model produces a range of radial diffusive anisotropy from 10% to 17% for $v_{m}$ from $10^{6}$ to $10^{7}$ cm/sec (the observed $v_{m}$ is 165). The range of $v_{m}$ is comparable to that previously reported using a similar, but time-dependent, model that best fit the temporal development of present solar particle events. A $v_{m}$ of $10^{7}$ cm/sec produces a modulation factor of 11 between 1 AU and 3 AU. Evidence for comparable modulation in corotating streams has been found by Pioneer XI. The approximately linear dependence of the diffusive anisotropy on the wind speed predicted by the model is found to be consistent with the observed dependence.

SEC 76 EFFECTIONS OF PARTICLE DRIFT ON SOLAR MODULATION OF GALACTIC COSMIC RAYS J. R. Jokipii (Department of Planetary Sciences, University of Arizona, Tucson, Arizona 85721) E. Levay, W. B. Hubbard (both at: Department of Planetary Sciences, University of Arizona, Tucson, Arizona 85721)

Although gradient and curvature drifts are explicitly contained in the general equations of cosmic-rays, they have been almost universally neglected in applications of these equations. We evaluate the drifts explicitly for the Parker spiral magnetic field and show that, for particles with rigidities greater than 3.0 GeV/c, they are larger than the solar-wind velocity over much of the heliosphere. The occurrence of solar modulation and solar-flare particle events neglect terms in which many are not as important as those retained. Calculations are presented which demonstrate the importance of the effect of drifts for modulation models. We conclude that comparisons of presently available model calculations with observations do not provide a fair test of transport theory since they neglect drifts. Results of Monte Carlo simulations show that the heliospheric cosmic-ray gradient and mean energy can be significantly reduced by the inclusion of drifts.

SEC 74 METEORITE GRADIENTS AND THE MAUNDER MINIMUM M. A. Forman D. A. Schaeffer (all at: Dept. of Earth and Space Sciences, State Univ. of New York at Stony Brook, N. Y. 11794)

A recent compilation of 58 measurements of the Argon-39 (269 year half-life) activity in the metallic phase of meteorites showed values of 22.5 ± 7.5 dpm/kg. This spread could be due to experimental errors alone, and the true variation is probably smaller. Since such a sample of meteorites can reasonably be expected from meteorite data to have a spread of mean distances from the sun of 2.5 ± 1 AU, an upper limit of 10%/AU on the effect of a climatic fluctuation.

Solar-Planetary Relationships: Magnetospheric Physics


Four days of simultaneous auroral zone electric field measurements on balloons flown from six sites spaced 180° in magnetic longitude have been analyzed. The average electric field behavior during these magnetically very quiet epochs is consistent with earlier single point measurements. When these data are mapped to the equator, a steady dawn-to-dusk component is apparent only on the average, while statistically the field is quite variable. The ionospheric electric field during isolated substorms is shown to have differing signatures east and west of 2200 LT. A world wide positive correlation is shown to exist between the auroral zone electric field strength and the intensity of terrestrial kilometric radiation.

EVIDENCE FOR DRIFT WAVES AT THE PLASMAPAUSE J. A. Hornbeck (Dept. of Physics and Astronomy, Univ. of Iowa, Iowa City, IA 52240)

As the Hughes-1 spacecraft crosses the plasmapause high-latitude regions between 10 and 15 °, a band of electric field noise is often detected in the frequency channels from 1.7 Hz to 178 Hz. The corresponding magnetic field noise is detected, indicating that the noise is electrostatic (or at least quasi-electrostatic), and the electric field is polarized perpendicular to the plasma sheet. The noise is only detected when the scale length of the plasmapause is 0.1 R or less, indicating that a large density gradient is required to produce the noise. These characteristics are all consistent with the interpretation of the noise as electrostatic waves excited by the drift mode instability. Using this interpretation we are able to identify the equatorial plasmapause latitude for a given value of $N$. The observed electric field spectrum can be explained as due to wavelet shifts caused by the spacecraft motion through the plasma.

RELATION BETWEEN BOUNCE-AVERAGED COLLISIONAL TRANSPORT COEFFICIENTS FOR GEOMAGNETICALLY TRAPPED ELECTRONS Michael Schulz (Space Sciences Laboratory, The Aerospace Corporation, El Segundo, California 90249)

The unwighted bounce average ($N_{i}$) of the atmospheric density ($N$) along a flux tube and the weighted bounce average ($N_{w}$/Cos$\theta$) are related (for each atmospheric constituent $j$ by an integral or derivative with respect to the sine of the equatorial pitch angle $\theta$, where $N_{j}$ (Cos$\theta$) is the ratio of location to equatorial magnetic-field intensity and $\theta$ is the local pitch angle. The unwighted bounce average ($N_{i}$) is relevant to energy deposition by radiation-belt particles of all species, but the weighted bounce average ($N_{w}$/Cos$\theta$) is relevant to the description of pitch-angle diffusion of radiation-belt electrons. The precise relationship between the two averages is given by

$$N_{i} = \frac{1}{2} \left( N_{w} / \cos \theta \right) + \frac{1}{2} z N$$

where $z$ is the full bounce period (a function of $\theta$).