minutes. The magnetosphere, which was in MHD equilibrium with the solar wind before the shock, is suddenly put out of dynamical equilibrium by the increased pressure behind the shock; for a plasma-sheet adiabatic index that is less than 2, Birn and Schindler [J. Geophys. Res., 88, 6969, 1983] have predicted that this global magnetotail flow should be directed earthward as the magnetotail seeks its new equilibrium. These four ISEE-3/ISEE-2 interplanetary shock intervals are very useful for magnetospheric physics because (a) the adiabatic index of the magnetospheric plasma can be measured by ISEE-2 during the shock compression of the magnetosphere and (b) the spatial structure of turbulence in the magnetotail can be viewed as the global earthward flows sweep the plasma and magnetic fields past the ISEE-2 satellite.

SH21B-09 1115h

Post-shock ULF Wave Activity Driven by Dynamic Pressure Variations

Harlan E Spence[1] (617-353-7412; spence@bu.edu)

Larry Kepko[1] (lkepko@bu.edu)

Timothy Guild[1] (tguild@bu.edu)

Elly Huang[1] (hcl@bu.edu)

[1]Boston University Center for Space Physics, 725 Commonwealth Avenue, Boston, MA 02215, United States

In this work we present analyses of events in which ULF wave activity was observed following the impact of an interplanetary shock. The transmission of compressional energy from the impact of such shocks on the magnetosphere has been postulated as a source for global cavity mode oscillations. We show that oscillations inside the magnetosphere following the shock passage are well correlated with oscillations of the solar wind dynamic pressure, a result unexpected from the cavity mode model. Rather than providing a broadband source of energy to the magnetospheric cavity, we suggest that the magnetospheric pulsations are directly driven by the dynamic pressure variations.

SH21B-10 1130h

AN ASSESSMENT OF THE US ELECTRIC POWER INDUSTRY HAZARD RISK DUE TO SSC, SC, SI AND RELATED MAGNETOSPHERIC SHOCK DISTRUBANCES

John G Kappenman (218-727-2666; john@metatechcorp.com)

Metatech, 5 West First Street Suite 301, Duluth, MN 55802, United States

A discussion will be provided on the impacts of large SSC shock events on the geomagnetic field and resulting impacts to electric power infrastructures caused by these events. Recent work by Metatech has shown that SSC events have been a large-scale threat to reliable operation of the power grid and that the impact of these disturbances can occur over very large geographic extent and can impact power systems even at very low-latitudes. Evidence of previous SSC events and impacts will be provided along with an assessment of potential threat impacts to the US and world electric power industry. Discussion regarding forecast needs for these events will also be provided.

SH22A MC: Hall D Tuesday 1330h

Cosmic Rays

Presiding: **J Kota,** University of Arizona

SH22A-0743 1330h POSTER

Long-Term Fluences of Energetic Particles in the Heliosphere

Richard A. Mewaldt[1] (626-395-6612; RMewaldt@srl.caltech.edu); Glenn M. Mason[2]; George Gloeckler[2]; Eric R. Christian[3]; Christina M. S. Cohen[1]; Alan C. Cummings[1]; Andrew J. Davis[1]; Joseph R. Dwyer[4]; Robert E. Gold[5]; Stamatios M. Krimigis[5]; Richard A. Leske[1]; Joseph E. Mazur[6]; Edward C. Stone[1]; Tycho T. von Rosenvinge[3]; Mark E. Wiedenbeck[7]; Thomas H. Zurbuchen[8]

[1]Caltech, 220-47 Downs Lab., Pasadena, CA 91125, United States

[2]University of Maryland, Department of Physics, College Park, MD 20742, United States

[3]Goddard Space Flight Center, Code 661.0, Greenbelt, MD 20771, United States

[4]Florida Institute of Technology, 150 W. University Blvd., Melbourne, FL 32901, United States

[5]Johns Hopkins University/Applied Physics Laboratory, 11100 Johns Hopkins Rd., Laurel, MD 20723, United States

[6]Aerospace Corporation, M2/259, Los Angeles, CA 90009, United States

[7]Jet Propulsion Laboratory, MS 169-327, Pasadena, CA 91009, United States

[8]University of Michigan, College of Engineering, Ann Arbor, MI 48109, United States

We report energy spectra of He, O, and Fe nuclei, extending from ∼0.3 keV/nucleon to ∼300 MeV/nucleon, integrated over the period from the Fall of 1997 to mid-2000. These fluence measurements were made at 1 AU using data from the SWICS,. ULEIS, SIS, and CRIS instruments on ACE, and include contributions from fast and slow solar wind, coronal mass ejections, pickup ions, impulsive and gradual solar particle events, acceleration in corotating interaction regions and other interplanetary shocks, and anomalous and galactic cosmic rays. Measurements of six additional species are presented in the energy region from ∼0.04 to ∼100 MeV/nucleon. We discuss the relative contributions of the various particle components, and comment on the shape and time dependence of the measured energy spectra. In the energy range from ∼10 keV/nucleon to ∼10 MeV/nucleon as many as 100 or more separate particle events somehow combine to produce E^{-2} power-law spectra that are common to all of the species measured, including ^{3}He. These are the first spectral measurements to extend continuously from solar-wind to cosmic-ray energies. Given the highly variable composition and intensity of the contributing events, the overall similarity of these fluence spectra is surprising.

SH22A-0744 1330h POSTER

The Ulysses fast latitude scan at solar maximum: COSPIN/KET observations

Bernd Heber[1] (49 541 969337; bheber@uni-osnabrueck.de); A. Posner[4] (posner@physik.uni-kiel.de); A. Raviart[2] (raviart@sapi01.saclay.cea.fr); P. Ferrando[2] (pferrando@cea.fr); C. Paizis[3] (osta@ifctr.mi.cnr.it); H. Kunow[4] (hkunow@physik.uni-kiel.de); R. Mueller-Mellin[4] (mueller-mellin@physik.uni-kiel.de); G> Wibberenz[4] (wibberenz@kernphysik.uni-kiel.de)

[1]Universitaet Osnabrueck, Fachbereich Physik, Universitaet Osnabrueck Barbarastr. 7, Osnabrueck 49079, Germany

[2]CEA, DAPNIA/Service d'Astrophysique CEA Saclay, Gif-sur-Yvette 91191, France

[3]CNR, Universitá di Milano, CNR, Universitá di Milano, Milano 20133, Italy

[4]IEAP, Institut für Experimentelle und Angewandte Physik, Universität Kiel,, Kiel 24118, Germany

Ulysses, launched in October 1990, began in December 1997 its second out of ecliptic orbit, and in September 2000 its second fast latitude scan. In contrast to the first fast latitude scan in 1994/1995 solar activity is close to maximum. It is important to note, that in addition to the different solar activity levels the solar magnetic field had reversed in 2000. While the first latitude scan gave a snapshot of the spatial distribution of galactic cosmic rays the second one is determined by temporal variations. Solar particle increases are observed at all heliographic latitudes, including events producing >250 MeV protons and ∼50 MeV electrons. Sources of MeV electrons in the inner heliosphere are 1) solar energetic particle events, 2) galactic cosmic rays, and 3) Jupiter. Since the first population is generally accompanied by energetic nucleons they can be distinguished from the other components by investigating e.g. 34-69 MeV protons. We found "quiet time" increases at all heliospheric latitudes, which indicate either very large perpendicular diffusion or the possibility of direct magnetic connection from low latitudes to polar regions. Concerning galactic cosmic ray modulation, we will compare the latitudinal gradient as well as the charge sign dependent variation for both Ulysses fast latitude scans.

SH22A-0745 1330h POSTER

Ulysses/KET Cosmic Ray Variability in Polar Coronal Hole Flow

Horst Kunow[1] (+49 431 880 2487; kunow@physik.uni-kiel.de)

Arik Posner[1] (+49 431 880 3221; posner@physik.uni-kiel.de)

Bernd Heber[2] (+49 541 969 3337; bheber@uni-osnabrueck.de)

Nathan A Schwadron[3] (+1 734 647 6834; nathanas@umich.edu)

Thomas H Zurbuchen[3] (+1 734 647 6835; thomasz@umich.edu)

[1]Extraterr. Physics IEAP Univ. Kiel, Leibnizstr. 11, Kiel 24118, Germany

[2]Fachbereich Physik Univ. Osnabrueck, Barbarastr. 7, Osnabrueck 49069, Germany

[3]Dept. AOSS Univ. Michigan, 2455 Hayward, Ann Arbor, MI 48109-2143, United States

Large-scale solar wind structures such as corotating interaction regions (CIRs) are responsible for recurrent modulation of galactic cosmic rays. High latitude observations of >125 MeV protons by Ulysses/COSPIN/KET give indications that modulation on the basis of the solar rotation period is present at high heliographic latitudes. The fact that the observations were recorded at latitudes beyond the reach of CIRs points towards the field model with large-scale motion of magnetic field lines introduced by Fisk [1996]. The model predicts direct magnetic connections of field lines at high and low latitudes. We investigate the nature of cosmic ray modulation for the 1993/1994 Ulysses south polar pass by applying a 3-D field line mapping technique based on this field model. The results will be discussed.

SH22A-0746 1330h POSTER

The Mean Free Pathlength of Anomalous Cosmic Rays in the Outer Heliosphere at Solar Maximum

A. C. Cummings[1] (626-395-6708; ace@srl.caltech.edu)

E. C. Stone[1] (626-395-8321; ecs@srl.caltech.edu)

[1]California Institute of Technology, Mail Code 220-47, Pasadena, CA 91125, United States

By December 2001, the Voyager 1 (V1) spacecraft will be at 83.1 AU and 33.8° North heliographic latitude and Voyager 2 (V2) will be at 65.7 AU and 23.1° South. At that time, the reversal of the Sun's magnetic field, which was complete at the Sun by the beginning of 2001, should be complete in the vicinity of the Voyager spacecraft. The current sheet should still be highly inclined in the outer heliosphere and the anomalous cosmic ray (ACR) intensities should be near their minimum values. By comparing the intensities of ACRs at V1 and V2 we will infer the magnitude and rigidity dependence of the particle mean free path in the outer heliosphere at solar maximum and compare the results with those obtained during the previous solar maximum period in 1990-91.

This work was supported by NASA under contract NAS7-1407.

SH22A-0747 1330h POSTER

Small Residual Modulation of >2.5 GV Anomalous Cosmic Rays at 81 AU

Edward C Stone[1] (626-395-8321; ecs@srl.caltech.edu)

Alan C Cummings[1] (626-395-6708; ace@srl.caltech.edu)

[1]California Institute of Technology, 220-47 Downs Laboratory, Pasadena, CA 91125, United States

The flux of >13 MeV/nuc anomalous cosmic ray oxygen observed by ACE at 1 AU has been reduced by a factor of more than sixty during the current solar maximum. However, the recent arrival of solar maximum conditions in the outer heliosphere has resulted in a reduction of less than factor of two at Voyager 1 at 81 AU. This indicates there is little residual modulation between Voyager 1 and the ACR source at the termination shock for ions with rigidities greater than 2.5 GV. The modulation between Voyager 1 and Voyager 2 at 64 AU is somewhat larger, suggesting that Voyager 1 is closer to the shock than to Voyager 2. The most recent observations will be compared with model calculations to estimate the remaining distance between Voyager 1 and the termination shock.

This work was supported by NASA under contract NAS7-1407.

SH22A-0748 1330h POSTER

Modulation of ACR Oxygen at 1 AU and the Topology of the Heliospheric Current Sheet

Luke Sollitt[1] ((626) 584-6757; sollitt@srl.caltech.edu); A C Cummings[1]; E C Stone[1]; R A Leske[1]; R A Mewaldt[1]; M E Wiedenbeck[2]; E R Christian[3]; T T von Rosenvinge[3]

[1]California Institute of Technology, M/C 220-47, Pasadena, CA 91125, United States

[2]Jet Propulsion Laboratory , MS 169-327, Pasadena, CA 91109, United States

[3]NASA/Goddard Space Flight Center, Code 661, Greenbelt, MD 20771, United States

Between late 1997 and mid-2001, the flux of $\sim$ 10 MeV/nuc anomalous cosmic ray (ACR) oxygen at 1 AU has decreased by a factor of over 100. Comparison of the time profiles of the oxygen intensity at $\sim$ 7-16 MeV/nuc at 1 AU and in the outer heliosphere suggests that there are two processes affecting this modulation. Between 1997 and 2000, there are three structures that cause step decreases at 1 AU but not in the outer heliosphere. In 2000, these steps are followed by a major decrease and the effective disappearance of ACR oxygen at 1 AU. Although smaller, this decrease is also seen in the outer heliosphere as the onset of durable modulation. We compare the timing of this decrease and subsequent changes in the ACR oxygen intensity with changes in the increasingly complex topology of the heliospheric current sheet during the reversal of the solar magnetic field. This work was supported by NASA under grant NAG5-6012 and contract NAS7-1407.

SH22A-0749 1330h POSTER

Radial and Latitudinal Intensity Gradients of Anomalous Cosmic Rays During the Solar Cycle 22 Recovery Phase

Matthew E Hill[1] (301-405-6232; hill@umdsp.umd.edu)

Douglas C Hamilton[1] (douglas.c.hamilton@umail.umd.edu)

Stamatios M Krimigis[2] (tom.krimigis@jhuapl.edu)

[1]Department of Physics, University of Maryland, College Park, MD 20742-4111, United States

[2]Applied Physics Laboratory, Johns Hopkins University, Laurel, MD 20723, United States

The structure of the heliosphere can be probed by studying the spatial intensity gradients of anomalous cosmic ray (ACR) ions because the transport of these particles is influenced by heliospheric phenomena such as the solar wind, heliomagnetic turbulence, and large-scale drift processes. Moreover, the ACR source itself is thought to be within the heliosphere, namely, at the termination shock of the solar wind. Calculation of non-local radial and latitudinal intensity gradients requires three separate, simultaneous observation positions, such as the Voyager 1 and 2 spacecraft and the well-monitored near-Earth region of space, from which suitable ACR observations are available. Unfortunately, with such large spacecraft separations, the considerable assumptions needed concerning the form and spatial dependence of the intensity gradients place the meaningfulness of this sort of gradient determination in question. Although the non-local method is appropriate for widely-spaced spacecraft if the spatial gradients are small or well-understood, there is no a priori reason to expect low-energy ACRs, for example, to meet this restriction. Fortunately, with an alternative method, it is possible to calculate gradients by making primarily temporal rather than the spatial assumptions, utilizing fewer than three spacecraft. Since, during the most recent recovery phase, a single form for the temporal dependence, 1-exp(-t), is widely observed to successfully describe cosmic ray measurements, while knowledge of the local spatial structure between the inner and outer heliosphere is quite limited, use of the alternative gradient method is appropriate. We present this method, calculate radial and latitudinal intensity gradients using ACR measurements from the Voyager LECP instruments, and discuss the implications these results have on our understanding of ACR transport and the structure of the heliosphere.

SH22A-0750 1330h POSTER

A New Model of the Galactic Cosmic Ray Radiation Environment at 1 AU based on ACE Measurements

Andrew J. Davis[1] ((626) 3977148; ad@srl.caltech.edu); R. A. Mewaldt[1] (rmewaldt@srl.caltech.edu); W. R. Binns[2] (wrb@howdy.wustl.edu); E. R. Christian[3] (erc@cosmicra.gsfc.nasa.gov); C. M. S. Cohen[1] (cohen@srl.caltech.edu); A. C. Cummings[1] (ace@srl.caltech.edu); J. S. George[1] (george@srl.caltech.edu); R. A. Leske[1] (leske@srl.caltech.edu); E. C. Stone[1] (ecs@srl.caltech.edu); T. T. von Rosenvinge[3] (tycho@lheamail.gsfc.nasa.gov); M. E. Wiedenbeck[4] (mew@heag1.jpl.nasa.gov); N. E. Yanasak[1] (yanasak@srl.caltech.edu)

[1]California Institute of Technology, Space Radiation Laboratory, Mail Code 250-22, Pasadena, CA 91125, United States

[2]Washington University, Department of Physics, St. Louis, MO 63130, United States

[3]NASA/Goddard Space Flight Center, Laboratory for High Energy Astrophysics, Greenbelt, MD 20771, United States

[4]Jet Propulsion Laboratory, California Institute of Technology, Pasadena, CA 91109, United States

The spectra of galactic cosmic ray (GCR) elements from Beryllium to Nickel in the energy range 40 - 500 MeV/nucleon at 1 AU are being continuously measured by instruments on-board the Advanced Composition Explorer (ACE). The collecting power of these instruments allows statistically precise spectra to be calculated every few months for most elements. Measurements of temporal variations in GCR spectra over the solar cycle are important for understanding solar modulation processes, and also for refining models of the near-earth radiation environment used to perform shielding and dose calculations for manned and unmanned space missions. We report on ACE observations of the evolution of GCR element spectra from solar minimum in 1997 through Fall 2001, and we describe a cosmic ray interstellar propagation and solar modulation model that provides an improved fit to the ACE measurements compared to radiation environment models currently in use. We intend to provide online access to this model from the ACE website.

This work was supported by NASA contract NAG5-6912.

URL: http://www.srl.caltech.edu/ACE

SH22A-0751 1330h POSTER

Modulation of Cosmic Rays in Heliomagnetic Fields with Organized Meridional Components

Jozsef Kota[1] (520-621-4396; kota@lpl.arizona.edu)

J. R. Jokipii[1] (520-621-4256; jokipii@lpl.arizona.edu)

[1]University of Arizona, University of Arizona, Lunar and Planetary Laboratory, Tucson, AZ 85721-0092, United States

We discuss the potential role the meridional component of the large-scale heliospheric magnetic field (HMF) may play in the transport of energetic charged particles. The standard Archimedean spiral lines of the steady, large-scale HMF has no latitudinal component. Hence latitudinal transport of cosmic rays may occur through particle drifts and cross-field diffusion only. Most of the numerical works developed so far were built on and taking advantage of this presumption. The inclusion of additional meridional field components into the transport-equation is straightforward conceptually but is still posing serious challenges for numerical models.

Here, we consider examples where organized latitudinal field components are of importance. A 3-dimensional, time dependent numerical code is developed and applied to idealized cases, where the motion of the footpoints of magnetic field lines can be described as a superposition of rotations. We address the Fisk field as the prime target of the present work. Also discussed are the meridional fields that inescapably emerge in connection with the reorganization of the global HMF as the tilt angle of the heliospheric current sheet (HCS) changes. The presence of a small organized latitudinal field is important if cross-field diffusion ($\kappa_\perp$) is small. Our numerical code is custom-designed for this purpose and is optimized for small $\kappa_\perp$. Results of numerical simulations will be presented.

SH22A-0752 1330h POSTER

Diffusive-Compressive Acceleration of Charged Particles

Jack R. Jokipii[1] (520-621-4256; jokipii@lpl.arizona.edu)

J. Giacalone[1] (520-621-4396; giacalon@lpl.arizona.edu)

J. Kóta[1] (520-621-5396; kota@lpl.arizona.edu)

[1]Department of Planetary Sciences, University of Arizona, Tucson, AZ 85721, United States

We consider the transport of energetic particles in a medium through which gradual (non-shock) compressions exist and propagate. As is the case with shocks, these compressions can accelerate charged particles. We have previously considered such acceleration in the specific context of CIRs (Giacalone, J., Jokipii, and Kóta, Joint SOHO-ACE Symposium Proceedings, in press, 2001). There we suggested that it may explain CIR-related energetic particles observed in the inner Heliosphere, near 1 AU, well inside of the radius where the co-rotating shock has formed.

Here we extend this concept to the general problem of acceleration by non-shock compressions, and consider primarily the limit in which the particle motion is diffusive. The relevant dimensionless parameter is the ratio R_c of the characteristic compression length scale L to the diffusive skin depth $\Delta_D = \kappa/U$, where U is the velocity and κ is the diffusion coefficient. Clearly, $R_c = UL/\kappa$. If $R_c \ll 1$, the results reduce to those of diffusive shock acceleration. We present the results from solving the transport equation for a variety of compressive disturbances with various values of R_c, and find significant charged-particle acceleration. We discuss the physics of this acceleration and the dependence on the various parameters.

Possible applications of this mechanism to heliospheric and other contexts will be discussed. We sugggest that in some cases this new form of acceleration may help to explain observations.

SH22B MC: Hall D Tuesday 1330h

Interstellar Gas, Dust, and Heliopause

Presiding: **R Wimmer-Schweingruber,** University of Bern

SH22B-0753 1330h POSTER

Investigations of the Origin of the "Inner Source" of Heliospheric Pick-up Ions

Robert F. Wimmer-Schweingruber[1] (41 31 631 44 20; wimmer@phim.unibe.ch)

Peter Bochsler[1] (bochsler@soho.unibe.ch)

[1]Physikalisches Institut, University of Bern,, Sidlerstrasse 5,, Bern CH-3012, Switzerland

The recently discovered "inner source" of heliospheric pick-up ions is currently ascribed to the liberation of implanted solar wind atoms from interplanetary dust particles that are saturated with solar wind gas.

Since the launch of SOHO, the LASCO instrument has observed a large number of sun-grazing comets; typically one is observed every few days. Such comets contribute a significant amount of small dust particles to the dust inventory of the inner heliosphere. Typical lifetimes against the Poynting-Robertson effect for very small ($\sim$ 100Å) particles are on the order of a few tens of years, resulting in significant accumulation of small particles in the innermost parts of the heliosphere.

Such small particles dominate the geometrical cross section of dust but do not saturate with solar wind because it is not trapped. Typical solar wind ranges in dust (SiO_2) are on the order of few 100 Å. However, the solar wind that is not trapped but transmitted through these particles looses a significant fraction of its kinetic energy and all memory of its initial charge state. The most probable charge state of the transmitted particles are neutral atoms and singly charged ions.

We investigate the validity of this scenario as an alternative explanation of the inner source of pick-up ions.

SH22B-0754 1330h POSTER

The Magnetization of the Protosolar Disk by Charged Dust - Neutral Gas Friction

Heinz Wiechen[1] (+49-89-32993510; wiechen@mpe.mpg.de)