Daniel Hubert[2,3] (hubert@chem.ubc.ca)

Stuart Bale[1] (bale@ssl.berkeley.edu)

David Larson[1] (larson@ssl.berkeley.edu)

Bob Lin[1] (lin@ssl.berkeley.edu)

[1]Space science Laboratory, University of California, Berkeley, CA, United States

[2]Observatoire de Paris, Place Janssen, Meudon 92195, France

[3]IAM, University of British Columbia, Main Mall, Vancouver, Canada

The non equilibrium characteristics of the solar wind electron distribution functions (EDF) at 1 AU are of great importance in many aspects, for instance in understanding heat conduction, plasma microinstabilities and transport in weakly collisional plasma, as well as in the scenario at the origin of the solar wind. It has been known for a long time that, in the free solar wind, EDF display both thermal ("core") and suprathermal ("halo" and "strahl") populations; more recently a super-halo population has also been identified. The usual model used to characterize the observed solar wind EDF is a sum of two bi-Maxwellians, the core-halo model, with a core-halo drift velocity oriented along the interplanetary magnetic field. Other recent works have emphasized the Lorentzian nature of EDF, i.e. the importance of their suprathermal tails, which should play a crucial role in the exospheric expansion of the slow and fast solar wind. Based on either the core-halo or Lorentzian (or Kappa) models, kinetic instabilities in space plasma have been discussed in the literature and wave growth rates have ben calculated. However both models are not appropriate to accurately characterize the solar wind EDF because they do not account properly for some important features of observed EDF. It is therefore important to characterize more precisely the nature of the EDF in the two typical solar winds. The 3DP experiment on the WIND spacecraft provides measurements of the full 3D electron distributions from energies of few ev to above 100 Kev, with a high-sensitivity, wide dynamic range, good energy and angular resolutions, and high time resolution. WIND's in-ecliptic orbits cover prolongated periods in the ambient, slow and fast, solar wind near L1, during the last minimum of solar activity. New characteristics of EDF are established and their consequences in different field of space plasma processes are discussed.

SH53B-05 1430h

Low Density Anomalies and Sub-Alfvénic Events in the Solar Wind

Arcadi V. Usmanov[1] (301 286-1033; arcadi.usmanov@gsfc.nasa.gov)

Melvyn L. Goldstein[1] (301 286-7828; melvyn.l.goldstein@nasa.gov)

[1]NASA Goddard Space Flight Center, Code 692, Greenbelt, MD 20771, United States

Spacecraft observations show that solar wind near Earth orbit is usually highly super-Alfvénic with an average Alfvén Mach number of 8.4. *Gosling et al.* (JGR, *87*, 239, 1982) showed that during the low density events of July 4, July 31, and November 22, 1979 the solar wind became sub-Alfvénic. We use the recently released OMNI 2 spacecraft data compilation for 1963-2003 to select 23 intervals with abnormally low densities of 0.3 cm^{-3} or less and among them 9 events with Alfvén Mach number less than unity. We discuss a correlation between minimum Alfvén Mach numbers and minimum densities for the selected events. Using a time-dependent MHD simulation, we show that a very strong rarefaction with an embedded sub-Alfvénic region can develop on the trailing edge of a fast flow.

SH53B-06 1445h

Cross-Field Energy Transfer of a Planar Alfvén Wave Propagating Along and Across a Pressure-Balanced Structure

Bernard J Vasquez[1] (603-862-1110; bernie.vasquez@unh.edu)

Joseph V Hollweg[1] (joseph.hollweg@unh.edu)

[1]University of New Hampshire, Space Science Center, University of New Hampshire, Durham, NH 03824, United States

We present hybrid numerical simulation results with particle protons and fluid electrons of a low-frequency, planar (body) and shear Alfvén wave located within a smoothly varying cross-field pressure-balanced structure which provides a wave-speed gradient. We consider wave propagation directions starting at 90^o, which resembles the case of a surface wave on an interface, and less than 90^o with respect to the gradient direction. We find that the planar Alfvén wave undergoes resonant absorption. When the propagation direction is less than 90^o, we show that there are resonant field lines which can actually give wave energy to other neighboring resonant field lines, which is a situation that has not been encountered in previous work with surface waves. A consequence of this process is an overall faster development time for smaller scales perpendicular to the magnetic field through phase mixing and potentially faster dissipation of these generated scales in coronal and solar wind plasma. In these collisionless simulations, dissipation of the small scales occurs via the Landau resonance.

SH54A CC: 519 A Friday 1530h

Solar Wind IV

Presiding: **M E Hill,** University of Maryland**; A Szabo,** NASA Goddard Space Flight Center

SH54A-01 1530h

Transport of cross helicity and the radial evolution of Alfvenicity in the solar wind

W H Matthaeus[1] (302-831-2780; whm@udel.edu); Jaco Minnie[2] (fskjm@puknet.puk.ac.za); B Breech[1] (breech@eecis.udel.edu); S Parhi[1] (sparhi@udel.edu); J W Bieber[1] (john@bartol.udel.edu); S Oughton[3] (Seano@waikato.ac.nz); B Bavassano[4] (bavassano@ifsi.rm.cnr.it)

[1]Bartol Research Institute, University of Delaware, Newark, DE 18716, United States

[2]Potchefstroom University, Potchefstroom, South Africa

[3]Department of Mathematics, University of Waikato, Hamilton, New Zealand

[4]Istituto di Fisica dello Spazio Interplanetario, Consiglio Nazionale delle Ricerche, Rome, Italy

A transport theory for cross helicity is described, including both scale-separated spatial transport and a phenomenological description of nonlinear effects associated with magnetohydrodynamic turbulence. The formalism is applied to the radial evolution of the solar wind, where driving effects of shear and pickup ions are included. It is found that the radial decrease of cross helicity observed in the equatorial solar wind can be accounted for when sufficient driving is included to overcome dynamic alignment, i.e., the inherent tendency for MHD turbulence to produce Alfvenic states. For the high latitude wind, which evolves under influence of a lower mean shear stregnth, the theory predicts a closer balance between dynamic alignment and shear strength effects, so that the normalized cross helicity, which generally decreases with increasing heliocentric radial distance, changes very little between 2 and 4 AU. This accounts well for Ulysses observations. This research supported in part by NSF grant TM-0105254, NASA grants NAG5-8134, NAG5-11603, NAG5-6570 and NAG5-10911, and the NZ Marsden Fund (02-UOW-050 MIS).

SH54A-02 1545h

Semi-Empirical Model of Electron Heat Flux: SOHO and Ulysses Data

Edward C Sittler[1] (301 286 8215; Edward.C.Sittler@nasa.gov); Ruth Skoug[2] (rskoug@lanl.gov); Leon Ofman[3] (ofman@waves.gsfc.nasa.gov); Sarah Gibson[4] (sgibson@hao.ucar.edu); Thomas Holzer[4] (holzer@hao.ucar.edu); Andrezej Fludra[5] (fludra@cdso8.nascom.nasa.gov)

[1]NASA/GSFC, NASA/GSFC Code 692, Greenbelt, MD 20771, United States

[2]Los Alamos National Lab, LANL Group NIS-1 MS D466, Los Alamos, NM 87545, United States

[3]The Catholic University of America, NASA/GSFC Code 682, Greenbelt, MD 20771, United States

[4]High Altitude Observatory, HAO/NCAR 3450 Mitchell Lane, Boulder, CO 80301, United States

[5]Rutherford Appleton Laboratory, Rutherford Appleton Laboratory, Oxon OX11 0QX, United Kingdom

We have developed a semi-empirical model of the electron heat conduction which is based on both theoretical and observational considerations. Most specifically we are most interested in applying this model to the polar regions of the Sun during solar minimum where suprathermal tails may form. This model is a 'local model' which uses the Krook's anzatz in the Boltzmann equation using the collision term $(\delta f^*/\delta t)_{coll} = -(f^* - f_0^*)/\tau$ where $\tau = (\lambda_w/w_c)(u^3/(u^4 + \lambda_w/\lambda_{coul}))$ is the collision time, λ_w is a characteristic 'local' scattering length due to waves, λ_{coul} is a characteristic collision length 'local' due to coulomb collisions, $u = (w/w_C)$, w_c is the thermal speed of the core electrons, w is the electron speed in the electron proper frame, and $f^* = f_0^* + f_1^*$, where f^* is the proper frame electron distribution function, f_0^* is the unperturbed electron distribution function and f_1^* is the perturbed correction term due to plasma gradients and collisions. Assuming a kappa distribution function for f_0^* we can compute an expansion of the Boltzmann equation and derive an expression for f_1^* with some undetermined parameters. Then by imposing constraint of particle conservation $\int f_{e1}^* d^3w = 0$, the zero current condition $j_{ll}^* = -e\int f_{e1}^* w_{ll} d^3w = 0$ to give us a relationship for the interplanetary potential, and we can then reduce the number of free parameters. Then by specifying the logarithmic derivative of the electron density, core electron temperature and the magnetic field from the base of the corona to 1 AU using SOHO and Ulysses data we can derive a relationship for κ and thus f_1^* with λ_w as a free parameter. Once this is done we can use the relationship $q_{ell}^* = \frac{1}{2} m_e \int f_{e1}^* w^2 w_{ll} d^3w$ to give us the electron heat flux along **B** and then set it equal to q_{eff} from the semi-empirical MHD model by Sittler and Guhathakurta (1999,2002) to constrain λ_w which tell us how important waves are (i.e., whistler mode waves) with respect to coulomb collisions as a function of radial distance from the Sun. Preliminary results were presented by Sittler et al. (2001). Our most results have been improved from that previously presented and will use a comprehensive analysis of Ulysses solar wind electron data.

SH54A-03 1600h

Pickup ion transport in the inner heliosphere, a statistical study

Lukas a Saul[1] (6034362875; lukas.saul@unh.edu)

Eberhard Möbius[1] (eberhard.moebius@unh.edu)

[1]University of New Hampshire, 17 Library Way, Durham, nh 03824, United States

Statistical studies of high time resolution in situ measurements of interstellar helium pickup ions using SOHO/CELIAS/CTOF and ancillary data are reported. These singly charged helium ions act as test particles in the solar wind due to their low relative density in the inner heliosphere. These studies have shown new correlations to solar wind parameters such as proton density, magnetic field direction & magnitude, and MHD wave power. Statistical analysis enables quantitative analysis of pitch angle scattering rates and also shines new light on stochastic acceleration and wave-particle interactions. Also reported are the effects of changing ionization rates on the interstellar pickup ion velocity distributions.

SH54A-04 1615h

Temporal Variations of Low-Energy Helium Observed by Voyager1 in 2002-2003

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

A C Cummings[1]

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

During the enhanced intensities at low energies observed by Voyager 1 at >85 AU in 2002, the helium appears to have two distinct components. Above 10 MeV/nucleon, it is consistent with that of modulated anomalous cosmic rays, while it is a power law at lower energies indicating no energy-dependent modulation. The two components exhibit distinctly different time dependent variations which may provide clues as to their differing origins.

SH54A-05 1630h

Reappearance of Enhanced Intensities of Low-Energy Particles at Voyager 1 in mid-2003

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

E C Stone[1]

F B McDonald[2]

W R Webber[3]

N Lal[4]

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

[2] University of Maryland, Computer and Space Sci Bldg 3245, College Park, MD 20742, United States

[3] New Mexico State University, P.O. Box 30001, Las Cruces, NM 88003, United States

[4] Goddard Space Flight Center, Code 933, Greenbelt, MD 20771, United States

Beginning mid-2003 the >0.5 MeV/nuc ion intensity measured by the Cosmic Ray experiment on Voyager 1 (V1) (at 88.8 AU and 33.9°N) began to increase and by early Feburary 2004 had reached the same level as during the earlier 2002 event. The intensities at Voyager 2 (V2) (70.6 AU and 24.5°S) did not show a corresponding increase. The 2002 event lasted ~7 months and was characterized by a low-energy particle intensity increase at V1 by two or more orders of magnitude with no corresponding increase at V2. The origin of this increase at V1 is currently under debate, with some suggesting that the solar wind termination shock was crossed, while others maintain that V1 remained upwind of the shock. The 2002 event has been fairly well characterized in terms of the particle energy spectra and streaming properties. The event ended in early 2003 with the intensities returning to near normal levels by 2003.4. We will characterize the energetic particle properties of the new 2003 event and compare with the properties of the 2002 event. This work was supported by NASA under contract NAS7-03001.

SH54A-06 1645h

Ion Energy Spectra Observed During the Ongoing Termination Shock Events at Voyager 1

Matthew E Hill[1] (301-405-6209; mehill@umd.edu)

Douglas C Hamilton[1] (douglas.c.hamilton@umail.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 position of the Voyager 1 (V1) spacecraft with respect to the solar wind termination shock (TS) during the V1 energetic particle events that began in mid-2002 remains a subject of debate. However, there does appear to be a general consensus that the spacecraft was in close proximity to the TS during a roughly six-month period ending in January 2003 and a second period beginning about August 2003. A consistent scenario has not yet been presented that explains the essential observations (i.e., large coherent particle intensity variations, outward azimuthal particle streaming, ~no net radial flow, low magnetic field, no Forbush decreases, and no comparable Voyager 2 event) so we seek more clues by analyzing the measurements from the first and subsequent events in increased detail. The focus is the spectral characteristics of the accelerated ion population and the higher-energy "modulated" anomalous cosmic rays (ACRs). We study the presumably two separate particle populations detected by the Low Energy Charged Particle experiment's 360° scan of the sky: the field-aligned streaming component and the remaining quasi-isotropic distribution of particles. By using as fine a temporal resolution as counting statistics allow, we will examine unresolved aspects of the first event, while reporting new observations of the more recent event. For example, by identifying certain transient spectral features—possibly due to very local transport effects—we attempt to estimate the local radius of curvature or acceleration time associated with the nearby TS. We emphasize the measurements that place significant constraints on theoretical interpretation and also highlight features that could suggest new approaches to understanding these puzzling observations.

URL: http://space.umd.edu/voyager