12TH ANNUAL
INTERNATIONAL ASTROPHYSICS CONFERENCE

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MYRTLE BEACH, SC

Outstanding problems in Heliosphysics: from coronal heating to the edge of the heliosphere

Sheraton Myrtle Beach Convention Center Hotel
Myrtle Beach, SC
April 15-19, 2013

12th Annual International Astrophysics Conference
Sheraton Myrtle Beach Convention Center Hotel
Myrtle Beach, SC, April 15 – 19, 2013

AGENDA

SUNDAY, APRIL 14	
5:30 PM – 8:00 PM	Registration – Ballroom A
6:30 PM – 9:30 PM	Welcome Reception - Ballroom A

MONDAY, APRIL 15		
7:00 AM - 5:00 PM	Registration – Ballroom E Foyer	
7:45 AM – 8:00 AM	Welcome Message from Gary P. Zank	
8:00 AM – 6:00 PM	GENERAL SESSION – Ballroom E	
CHAIR: GARY P ZANK		
8:00 AM - 8:25 AM	Möbius, Eberhard	Interstellar Gas Flow Determination with IBEX after 4 Years
8:25 AM - 8:05 AM	Mueller, Hans	Interstellar helium in the heliosphere: Modeling
8:50 AM - 9:15 AM	Slavin, Jonathan	IBEX, SWCX and a Consistent Model for the Local ISM
9:15 AM - 9:40 AM	Pogorelov, Nikolai	Interpretation of Voyager Measurements in the Heliosheath
9:40 AM - 10:05 AM	Scherer, Klaus	Ionization Processes in the Heliosphere
10:05 AM - 10:30 AM	Morning Break - Ballroom E Foyer	
CHAIR: KLAUS SCHERER		
10:30 AM - 10:55 AM	Zank, Gary P.	Heliospheric Structure: The Bow Wave and the Hydrogen Wall
10:55 AM - 11:20 AM	Cummings, Alan	Voyager Observations of Energetic Particles in the Distant Heliosheath
11:20 AM - 11:45 AM	Krimigis, Stamatios	Search for the Exit: Voyager 1 at Heliosphere's Border with the Galaxy
11:45 AM - 12:10 PM	Decker, Robert	Recent Measurements of Energetic Particles from Voyager 1 in the Heliosheath Depletion Region and Voyager 2 in the Heliosheath
12:10 PM - 1:30 PM	Lunch Break - Ballroom A	
CHAIR: OLGA VERKHOGLYADOVA		
1:30 PM - 1:55 PM	Reames, Donald	What Makes Gradual SEP Events Gradual?
1:55 PM - 2:20 PM	Cohen, Christina	The Charge-to-Mass Dependence of SEP Fluences Over Wide Longitudes
2:20 PM - 2:45 PM	Ng, Chee	Effects of the Spatial Profiles of the Solar-Wind Velocity, Magnetic Field, and Density on SEP Transport with Self-Amplified Alfven Waves
2:45 PM - 3:10 PM	Mason, Glenn	Fe Enhancements In SEP Onsets: Flare/CME Mixture Or Transport Effect?
3:10 PM - 3:30 PM	Afternoon Break - Ballroom E Foyer	
CHAIR: MARK WIEDENBECK		
3:30 PM - 3:55 PM	Qin, Gang	The Impulsive SEP events: A Comparison of Numerical Calculation Results and Observations by Spacecraft in Different Longitude
3:55 PM - 4:20 PM	Mewaldt, R.A.	A 360-Degree View of Solar Energetic Particle Events
4:20 PM - 4:45 PM	Drake, James	Multi X-line Magnetic Reconnection and Particle Acceleration
4:45 PM - 5:10 PM	van der Holst, Bart	The Electron and Proton Temperature Evolution of CMEs

AGENDA

5:10 PM - 5:35 PM	Lario, David	Longitudinal Dependence of SEP Peak Intensities as Evidence of CME-Driven Shock Particle Acceleration
5:35 PM - 6:00 PM	Feynman, Joan	Minima of the Centennial Gleissberg Cycles
SESSION ADJORNS		

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AGENDA

TUESDAY, APRIL 16		
7:00 AM - 5:00 PM	Registration – Ballroom E Foyer	
8:00 AM - 6:00 PM	GENERAL SESSION – Ballroom E	
CHAIR: STEFAAN POEDTS		
8:00 AM - 8:25 AM	Gamayunov, Konstantin	Interstellar Pickup Protons and Their Effects in the Outer Heliosphere
8:25 AM - 8:50 AM	Livadiotis, George	Large-scale Quantization in Space Plasmas
8:50 AM - 9:15 AM	Yoon, Peter	Effects of Kinetic Instabilities in the Solar Wind Modeling
9:15 AM - 9:40 AM	Scudder, Jack	Ubiquitous Non-Thermals in Astrophysical Plasmas
9:40 AM - 10:05 AM	Burrows, Ross	Toward Multi-scale Plasma Simulation Techniques
10:05 AM - 10:30 AM	Morning Break - Ballroom E Foyer	
CHAIR: STAMATIOS KRIMIGIS		
10:30 AM - 10:55 AM	DeForest, Craig	Connecting the Corona and Heliosphere Through Imaging
10:55 AM - 11:20 AM	Galvin, Antoinette	Case Studies of Solar Wind Extremes
11:20 AM - 11:45 AM	Pierrard, Viviane	A Kinetic Model of the Solar Wind
11:45 AM - 12:10 PM	Fuselier, Stephen	Low Energy Neutral Atoms from the Heliosheath
12:10 PM - 1:30 PM	Lunch Break - Ballroom A	
CHAIR: PETER YOON		
1:30 PM - 1:55 PM	Poedts, Stefaan	A New Paradigm for Solar Coronal Heating
1:55 PM - 2:20 PM	Raymond, John	Probing the Solar Corona with Comet Lovejoy
2:20 PM - 2:45 PM	Song, Paul	A Model of the Chromosphere: Heating, Structures, and Circulation
2:45 PM - 3:10 PM	Cooper, John	Solar Occultation Explorer (SOX)
3:10 PM - 3:30 PM	Afternoon Break - Ballroom E Foyer	
CHAIR: NIKOLAI POGORELOV		
3:30 PM - 3:55 PM	Matsumoto, Takuma	Alfven wave heating and acceleration above an open flux tube
3:55 PM - 4:20 PM	Ruzmaikin, Alexander	The Centennial Gleissberg Cycle.
4:20 PM - 4:45 PM	Schwadron, Nathan	Retention of Ions Producing the IBEX Ribbon
4:45 PM - 5:10 PM	Swisdak, Marc	A Porous, Layered Heliopause
5:10 PM - 5:35 PM	Ng, Chung-Sang	Distribution of Nanoflares as Spatially Resolved Current Sheets in the Solar Corona
5:35 PM - 6:00 PM	Gopalswamy, Nat	Source Regions of Ground Level Enhancement Events
SESSION ADJOURNS		

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AGENDA

WEDNESDAY, APRIL 17		
7:00 AM - 5:00 PM	Registration – Ballroom E Foyer	
8:00 AM - 6:00 PM	GENERAL SESSION – Ballroom E	
CHAIR: HARALD KUCHAREK		
8:00 AM - 8:25 AM	Zhao, Liang	In-situ Comparison of Polar-coronal-hole and Equatorial-coronal-hole wind at solar minima and solar maximum: ACE and Ulysses observations
8:25 AM - 8:50 AM	Leske, Richard	Observations of Loss Cone Pitch Angle Distributions of Solar Energetic Particles
8:50 AM - 9:15 AM	Wiedenbeck, Mark	The Interplanetary Population of Suprathermal Ions from Impulsive Solar Energetic Particle Events: Solar Cycle Variations
9:15 AM - 9:40 AM	Lepri, Susan	The Behavior of Solar Wind Heavy Ions During Solar Cycle 23
9:40 AM - 10:05 AM	Gloeckler, George	Supersonic Solar Wind Jets Surrounding the Heliosphere
10:05 AM - 10:30 AM	Morning Break - Ballroom E Foyer	
CHAIR: MARTIN LEE		
10:30 AM - 10:55 AM	Elliott, Heather A.	New Horizons Solar Wind Around Pluto (SWAP) Solar Wind Measurements from 5 to 23 AU
10:55 AM - 11:20 AM	Coates, Andrew	Surprises from Saturn - and implications for other environments
11:20 AM - 11:45 AM	McKenna-Lawlor, S.	The Scientific Objectives of ESA's Comet Orbiter ROSETTA and Lander PHILAE
11:45 AM - 12:10 PM	Adhikari, Laxman	Turbulence Transport Model Applied to Space Physics And Astrophysics
12:10 PM - 1:30 PM	Lunch Break - Ballroom A	
CHAIR: MIKHAIL MEDVEDEV		
1:30 PM - 1:55 PM	Li, Bo	Differences in Solar Wind Parameters Measured during the Cycle 23-24 and 22-23 Minima help tell what Turbulence-based Mechanisms heat the Solar Wind
1:55 PM - 2:20 PM	Boldyrev, Stanislav	The Physics of Subproton Turbulence in Astrophysical Plasmas
2:20 PM - 2:45 PM	De Koning, Curt	Getting under the skin of a CME
2:45 PM - 3:10 PM	Wan, Minping	Intermittency and Dissipation in MHD and Plasma Turbulence
3:10 PM - 3:30 PM	Afternoon Break - Ballroom E Foyer	
CHAIR: ROMANA RATKIEWICZ		
3:30 PM - 3:55 PM	Scime, Earl	Sources of Complex Ion Velocity Distributions in the Laboratory, in Space, and in Simulations
3:55 PM - 4:20 PM	Kharchenko, Vasili	ENA Transport and Energy Relaxation in the Interstellar Medium
4:20 PM - 4:45 PM	Mazelle, Christian	Influence of Nonstationary Dynamics of Collisionless Shock Front on Particle Reflection and Acceleration
4:45 PM - 5:10 PM	Dosch, Alexander	On Numerical Turbulence Generation for Test-Particle Simulations
7:00 PM - 9: 30 PM	Group Dinner – Ballroom A	

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AGENDA

THURSDAY, APRIL 18		
7:00 AM - 5:00 PM	Registration – Ballroom E Foyer	
8:00 AM - 6:00 PM	GENERAL SESSION – Ballroom E	
CHAIR: NAT GOPALSWAMY		
8:00 AM - 8:25 AM	Giacalone, Joe	The Formation of Suprathermal Particles by Acceleration of Thermal Plasma at Shocks
8:25 AM - 8:50 AM	Lukin, Vyacheslav (Slava)	Magnetic Reconnection in a Weakly Ionized Plasma
8:50 AM - 9:15 AM	Le Roux, Jakobus	Solar Energetic Particle Acceleration at Fast Coronal-Mass-Ejection-Driven Shocks.
9:15 AM - 9:40 AM	Lembege, Bertrand	Analysis of the Ion Quasi-Perpendicular Foreshock: 2D full PIC Simulations
9:40 AM - 10:05 AM	Li, Gang	Spectral Hardening of Solar Flare Continuum
10:05 AM - 10:30 AM	Morning Break - Ballroom E Foyer	
CHAIR: J.R. (RANDY) JOKIPII		
10:30 AM - 10:55 AM	Medvedev, Mikhail	Asymmetric Diffusion in Turbulent Magnetized Plasmas with a Mean Field Gradient
10:55 AM - 11:20 AM	Moraal, Harm	The Csmic-Ray Inversion Problem
11:20 AM - 11:45 AM	Kucharek, Harald	3D-Hybrid Simulations for the Evolution of Ion and ENA Distributions at the Termination Shock
11:45 AM - 12:10 PM	Washimi, Haruichi	MHD Analysis of the Solar Wind Structure from the Photosphere to the Heliosphere
12:10 PM - 1:30 PM	Lunch Break - Ballroom A	
CHAIR: GEORGE HO		
1:30 PM - 1:55 PM	Raeder, Joachim	Mechanisms of Mass, Momentum, and Energy Transfer Across Earth's Magnetopause
1:55 PM - 2:20 PM	Parks, George	Reinterpretation of Slowdown of Solar Wind Mean Velocity in Nonlinear Structures Observed Upstream of Earth's Bow shock
2:20 PM - 2:45 PM	Oka, Mitsuo	Non-thermal Electrons in Solar Flares and the Earth's Magnetotail
2:45 PM - 3:10 PM	Verkhoglyadova, Olga	Middle Atmosphere Response to Large SEP Events
3:10 PM - 3:30 PM	Afternoon Break - Ballroom C Foyer	
CHAIR: MARC SWISDAK		
3:30 PM - 3:55 PM	Hill, Matthew	Anomalous and Galactic Cosmic Rays Near the Heliocliff
3:55 PM - 4:20 PM	Ratkiewicz, Romana	Interstellar Magnetic Field in the Nearest Surroundings of the Sun
4:20 PM - 4:45 PM	Borovikov, Sergey	Investigating the Heliotail Structure with a MHD-kinetic Model
4:45 PM - 5:10 PM	Roelof, Edmond	The IBEX "Ribbon" Produced as a Consequence of Global Plasma Flow Patterns in the Heliosheath
5:10 PM - 5:35 PM	Kota, Jozsef	Galactic and Anomalous Cosmic Rays around the Heliopause
5:35 PM - 6:00 PM	Frisch, Priscilla	Small-scale Interstellar Structure and the Heliosphere
SESSION ADJOURNS		

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AGENDA

FRIDAY, APRIL 19		
7:00 AM - 5:00 PM	Registration – Ballroom E Foyer	
8:00 AM – 6:00 PM	GENERAL SESSION – Ballroom E	
CHAIR: HEATHER ELLIOTT		
8:00 AM - 8:25 AM	Ho, George	3He Enhanced Solar Energetic Particle Events in Cycle 24
8:25 AM - 8:50 AM	Wu, S. T.	Analyses of the Evolution and Interaction of Multiple Coronal Mass Ejections and Their Shocks in July 2012
8:50 AM - 9:15 AM	Hu, Qiang	Characteristics of Magnetic Flux Ropes from the Sun to the Heliosphere
9:15 AM - 9:40 AM	Jokipii, J. R. (Randy)	Fast-Charged-Particle Acceleration at Collisionless Plasma Compressions and Shear
9:40 AM - 10:05 AM	Kim, Tae	Modeling the Global Heliosphere Using IPS-derived Time-dependent Boundary Conditions
10:05 AM - 10:30 AM	Morning Break - Ballroom E Foyer	
CHAIR: HARM MORAAL		
10:30 AM - 10:55 AM	Golla, Thejappa	Non-linear Processes in Solar Type III Radio Bursts
10:55 AM - 11:20 AM	Lee, Martin	Fluence Energy Spectra of Ground Level Events
11:20 AM - 11:45 AM	Adams, Jim	Probabilistic Model for Solar Energetic Particle Events
END OF CONFERENCE		

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Talks By Participant

Adams, Jim	Fri, April 19	11:20 AM - 11:45 AM	Probabilistic Model for Solar Energetic Particle Events
Adhikari, Laxman	Wed, April 17	11:45 AM - 12:10 PM	Turbulence Transport Model Applied to Space Physics And Astrophysics
Boldyrev, Stanislav	Wed, April 17	1:55 PM - 2:20 PM	The Physics of Subproton Turbulence in Astrophysical Plasmas
Borovikov, Sergey	Thu, April 18	4:20 PM - 4:45 PM	Investigating the Heliotail Structure with a MHD-kinetic Model
Burrows, Ross	Tue, April 16	9:40 AM - 10:05 AM	Toward Multi-scale Plasma Simulation Techniques
Coates, Andrew	Wed, April 17	10:55 AM - 11:20 AM	Surprises from Saturn - and implications for other environments
Cohen, Christina	Mon, April 15	1:55 PM - 2:20 PM	The Charge-to-Mass Dependence of SEP Fluences Over Wide Longitudes
Cooper, John	Tue, April 16	2:45 PM - 3:10 PM	Solar Occultation Explorer (SOX)
Cummings, Alan	Mon, April 15	10:55 AM - 11:20 AM	Voyager Observations of Energetic Particles in the Distant Heliosheath
De Koning, Curt	Wed, April 17	2:20 PM - 2:45 PM	Getting under the skin of a CME
Decker, Robert	Mon, April 15	11:45 AM - 12:10 PM	Recent Measurements of Energetic Particles from Voyager 1 in the Heliosheath Depletion Region and Voyager 2 in the Heliosheath
DeForest, Craig	Tue, April 16	10:30 AM - 10:55 AM	Connecting the Corona and Heliosphere Through Imaging
Dosch, Alexander	Wed, April 17	4:45 PM - 5:10 PM	On Numerical Turbulence Generation for Test-Particle Simulations
Drake, James	Mon, April 15	4:20 PM - 4:45 PM	Multi X-line Magnetic Reconnection and Particle Acceleration
Elliott, Heather A.	Wed, April 17	10:30 AM - 10:55 AM	New Horizons Solar Wind Around Pluto (SWAP) Solar Wind Measurements from 5 to 23 AU
Feynman, Joan	Mon, April 15	5:35 PM - 6:00 PM	Minima of the Centennial Gleissberg Cycles
Frisch, Priscilla	Thu, April 18	5:35 PM - 6:00 PM	Small-scale Interstellar Structure and the Heliosphere
Fuselier, Stephen	Tue, April 16	11:45 AM - 12:10 PM	Low Energy Neutral Atoms from the Heliosheath
Galvin, Antoinette	Tue, April 16	10:55 AM - 11:20 AM	Case Studies of Solar Wind Extremes
Gamayunov, Konstantin	Tue, April 16	8:00 AM - 8:25 AM	Interstellar Pickup Protons and Their Effects in the Outer Heliosphere
Giacalone, Joe	Thu, April 18	8:00 AM - 8:25 AM	The Formation of Suprathermal Particles by Acceleration of Thermal Plasma at Shocks
Gloeckler, George	Wed, April 17	9:40 AM - 10:05 AM	Supersonic Solar Wind Jets Surrounding the Heliosphere
Golla, Thejappa	Fri, April 19	10:30 AM - 10:55 AM	Non-linear Processes in Solar Type III Radio Bursts
Gopalswamy, Nat	Tue, April 16	5:35 PM - 6:00 PM	Source Regions of Ground Level Enhancement Events
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Kharchenko, Vasili	Wed, April 17	3:55 PM - 4:20 PM	ENA Transport and Energy Relaxation in the Interstellar Medium
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Krimigis, Stamatios	Mon, April 15	11:20 AM - 11:45 AM	Search for the Exit: Voyager 1 at Heliosphere's Border with the Galaxy
Kucharek, Harald	Thu, April 18	11:20 AM - 11:45 AM	3D-Hybrid Simulations for the Evolution of Ion and ENA Distributions at the Termination Shock
Lario, David	Mon, April 15	5:10 PM - 5:35 PM	Longitudinal Dependence of SEP Peak Intensities as Evidence of CME-Driven Shock Particle Acceleration
Le Roux, Jakobus	Thu, April 18	8:50 AM - 9:15 AM	Solar Energetic Particle Acceleration at Fast Coronal-Mass-Ejection-Driven Shocks.
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Livadiotis, George	Tue, April 16	8:25 AM - 8:50 AM	Large-scale Quantization in Space Plasmas
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Mason, Glenn	Mon, April 15	2:45 PM - 3:10 PM	Fe Enhancements In SEP Onsets: Flare/CME Mixture Or Transport Effect?
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Medvedev, Mikhail	Thu, April 18	10:30 AM - 10:55 AM	Asymmetric Diffusion in Turbulent Magnetized Plasmas with a Mean Field Gradient
Mewaldt, R.A.	Mon, April 15	3:55 PM - 4:20 PM	A 360-Degree View of Solar Energetic Particle Events
Möbius, Eberhard	Mon, April 15	8:00 AM - 8:25 AM	Interstellar Gas Flow Determination with IBEX after 4 Years
Moraal, Harm	Thu, April 18	10:55 AM - 11:20 AM	The Csmic-Ray Inversion Problem
Mueller, Hans	Mon, April 15	8:25 AM - 8:05 AM	Interstellar helium in the heliosphere: Modeling
Ng, Chee	Mon, April 15	2:20 PM - 2:45 PM	Effects of the Spatial Profiles of the Solar-Wind Velocity, Magnetic Field, and Density on SEP Transport with Self-Amplified Alfven Waves
Ng, Chung-Sang	Tue, April 16	5:10 PM - 5:35 PM	Distribution of Nanoflares as Spatially Resolved Current Sheets in the Solar Corona
Oka, Mitsuo	Thu, April 18	2:20 PM - 2:45 PM	Non-thermal Electrons in Solar Flares and the Earth's Magnetotail
Parks, George	Thu, April 18	1:55 PM - 2:20 PM	Reinterpretation of Slowdown of Solar Wind Mean Velocity in Nonlinear Structures Observed Upstream of Earth's Bow shock
Pierrard, Viviane	Tue, April 16	11:20 AM - 11:45 AM	A Kinetic Model of the Solar Wind
Poedts, Stefaan	Tue, April 16	1:30 PM - 1:55 PM	A New Paradigm for Solar Coronal Heating
Pogorelov, Nikolai	Mon, April 15	9:15 AM - 9:40 AM	Interpretation of Voyager Measurements in the Heliosheath

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Verkhoglyadova, Olga	Thu, April 18	2:45 PM - 3:10 PM	Middle Atmosphere Response to Large SEP Events
Wan, Minping	Wed, April 17	2:45 PM - 3:10 PM	Intermittency and Dissipation in MHD and Plasma Turbulence
Washimi, Haruichi	Thu, April 18	11:45 AM - 12:10 PM	MHD Analysis of the Solar Wind Structure from the Photosphere to the Heliosphere
Wiedenbeck, Mark	Wed, April 17	8:50 AM - 9:15 AM	The Interplanetary Population of Suprathermal Ions from Impulsive Solar Energetic Particle Events: Solar Cycle Variations
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Yoon, Peter	Tue, April 16	8:50 AM - 9:15 AM	Effects of Kinetic Instabilities in the Solar Wind Modeling
Zank, Gary P.	Mon, April 15	10:30 AM - 10:55 AM	Heliospheric Structure: The Bow Wave and the Hydrogen Wall
Zhao, Liang	Wed, April 17	8:00 AM - 8:25 AM	In-situ Comparison of Polar-coronal-hole and Equatorial-coronal-hole wind at solar minima and solar maximum: ACE and Ulysses observations

SCHEDULE OF TALKS

NOTES

Monday, April 15: 8:00 AM - 8:25 AM
Presenter: Möbius, Eberhard

Interstellar Gas Flow Determination with IBEX after 4 Years

E. Möbius, Space Science Center & Department of Physics, University of New Hampshire, USA
P. Bochsler, Space Science Center & Department of Physics, University of New Hampshire, USA
M. Bzowski, Space Research Centre, Polish Academy of Sciences, Poland
S.A. Fuselier, Southwest Research Institute, USA
D. Heirtzler, Space Science Center & Department of Physics, University of New Hampshire, USA
M. Hłond, Space Research Centre, Polish Academy of Sciences, Poland
M. A. Kubiak, Space Research Centre, Polish Academy of Sciences, Poland
H. Kucharek, Space Science Center & Department of Physics, University of New Hampshire, USA
M.A. Lee, Space Science Center & Department of Physics, University of New Hampshire, USA
T. Leonard, Space Science Center & Department of Physics, University of New Hampshire, USA
D.J. McComas, Southwest Research Institute & University of Texas at San Antonio, USA
L. Saul, Physikalisches Institut, Universität Bern, Switzerland
N. Schwadron, Space Science Center & Department of Physics, University of New Hampshire, USA
J.M. Sokół, Space Research Centre, Polish Academy of Sciences, Poland
P. Wurz, Physikalisches Institut, Universität Bern, Switzerland

The Interstellar Boundary Explorer (IBEX) observes the interstellar neutral gas flow trajectories at their perihelion in Earth's orbit every year from December through late March, when the Earth moves into the oncoming flow. Surprisingly, the initial quantitative analysis resulted in a somewhat different interstellar flow vector with noticeably lower speed than obtained previously with Ulysses GAS, also compared with pickup ion and UV observations. In comparison with astronomical observations of the flow vectors of neighboring interstellar clouds, the IBEX observations locate the solar system within the Local Interstellar Cloud (LIC), contrary to previous determinations, which favor values between the LIC and the G-Cloud. This year, the fifth season is being accumulated, now providing a database over increasing solar activity and under varying viewing strategies. These recurring observations of the interstellar flow pattern and its spatial distribution allow us to consolidate the derivation of the surrounding interstellar conditions. We also track variations in the flow at 1 AU that may arise from solar cycle related changes in ionization and radiation pressure for H and explore any other variations in the neutral gas flow. We will review our observations, tests of their precision, and differences in methodology with previous observations, and discuss implications for the LIC and its interaction with the heliosphere in the light of a growing data set and improving analysis.

Monday, April 15: 8:25 AM - 8:05 AM
Presenter: Mueller, Hans

Interstellar helium in the heliosphere: Modeling

Hans-R. Mueller, Dept. of Physics and Astronomy, Dartmouth College and CSPAR, UAH, USA

The propagation of interstellar neutral helium atoms through the heliosphere proceeds on a background dominated by solar wind plasma protons and by interstellar hydrogen (both neutral and ionized). Interstellar helium has been observed by particle detectors (Ulysses, IBEX) and in scattered UV light in the inner heliosphere. To learn something about the local interstellar medium (ISM) and connect the measurements to helium characteristics far away in the pristine ISM, detailed modeling is required. It includes losses due to photoionization, charge exchange with heliospheric ions, and ionization via electron impact that helium experiences on the way. Moreover, charge exchange involving helium ions produces secondary neutral helium which needs to be taken into account in the modeling and the interpretation of measurements to avoid possible systematic deviations in the analysis. One such model, based on a conservative neutral trajectory method, is outlined, and key results for primary and secondary neutral helium are presented, including where they are predominantly lost and where secondaries measured in the innermost heliosphere are generated.

SCHEDULE OF TALKS | NOTES

Monday, April 15: 8:50 AM - 9:15 AM
Presenter: Slavin, Jonathan

IBEX, SWCX and a Consistent Model for the Local ISM

Jonathan D. Slavin, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

The Local Interstellar Medium (LISM) makes its presence felt in the heliosphere in a number of ways including inflowing neutral atoms and dust and shaping of the heliosphere via its ram pressure and magnetic field. Modelers of the heliosphere need to know the ISM density and magnetic field as boundary conditions while ISM modelers would like to use the data and models of the heliosphere to constrain the nature of the LISM. An important data set on the LISM is the diffuse soft X-ray background (SXRB), which is thought to originate in hot gas that surrounds the local interstellar cloud (LIC) in which the heliosphere resides. However, in the past decade or so it has become clear that there is a significant X-ray foreground due to emission within the heliosphere generated when solar wind ions charge exchange with inflowing neutrals. The existence of this SWCX emission complicates the interpretation of the SXRB. We will discuss how data from IBEX and models for the Ribbon in particular provide the possibility of tying together heliosphere models with models for the LISM, providing a consistent picture for the pressure in the LISM, the ionization in the LIC and the size and shape of the heliosphere.

Monday, April 15: 9:15 AM - 9:40 AM
Presenter: Pogorelov, Nikolai

Interpretation of Voyager Measurements in the Heliosheath

N.V. Pogorelov, Department of Physics and CSPAR, University of Alabama in Huntsville, USA
S.N. Borovikov, CSPAR, University of Alabama in Huntsville, USA
J. Heerikhuisen, Department of Physics and CSPAR, University of Alabama in Huntsville, USA
G.P. Zank, Department of Physics and CSPAR, University of Alabama in Huntsville, USA

We discuss nonstationary phenomena accompanying the solar wind (SW) interaction with the local interstellar medium (LISM) and their influence on the plasma flow and magnetic field distribution in the vicinity of the heliopause. This includes solar cycle, corotating interaction region, and global merged interaction region (GMIR) effects. We show that a "heliocliff" identified by Voyager 1 and exhibiting a stagnant flow region and a dramatic disappearance of the termination shock particles (TSPs) may be explained by time-dependence of the SW-LISM interaction, as well as the flow asymmetries caused by the interstellar magnetic field (ISMF). New results on the transition of the SW flow in the inner heliosheath to a chaotic, or turbulent, regime are presented.

Monday, April 15: 9:40 AM - 10:05 AM
Presenter: Scherer, Klaus

Ionization Processes in the Heliosphere

K. Scherer, H. Fichtner, H.-J. Fahr, M. Bzowski, S.E.S Ferreira

In the heliosphere, especially in the inner heliosheath, mass-, momentum-, and energy loading induced by the ionization of neutral interstellar species plays an important and for some species, especially \He, an underestimated role. We discuss the implementation of charge exchange and electron impact processes for interstellar neutral Hydrogen and Helium and their implications for further modeling. Especially, we emphasis the importance of electron impact and a more sophisticated numerical treatment of the charge exchange reactions. Moreover, we discuss the non-resonant charge exchange effects.

SCHEDULE OF TALKS

NOTES

Monday, April 15: 10:30 AM - 10:55 AM
Presenter: Zank, Gary P.

Heliospheric Structure: The Bow Wave and the Hydrogen Wall

G.P. Zank, J. Heerikhuisen, B.E. Wood, N.V. Pogorelov, and E. Zirnstein, University of Alabama in Huntsville, USA
D.J. McComas, Southwest Research Institute, USA

Recent IBEX observations indicate that the LISM flow speed is less than previously thought (23.2 km/s). Reasonable local interstellar medium (LISM) parameters show that the LISM flow may be either marginally super-fast magnetosonic or sub-fast magnetosonic. We address the questions of 1) can a LISM model that is barely super-fast or sub-fast magnetosonic account for Lyman-alpha observations that rely critically on the additional absorption provided by the hydrogen wall? and 2) if the LISM flow is weakly super-fast magnetosonic, does the transition assume the form of a traditional shock or does neutral hydrogen (H) mediate shock dissipation and hence structure through charge exchange? using three 3D self-consistently coupled MHD - kinetic H models with different LISM magnetic field strengths (2, 3, and 4 mG) and plasma and neutral H number densities. The 2 mG model admits a broad bow shock-like structure, the 3 mG model a very broad smooth super-fast-sub-fast transition resembling a bow wave. For both the 2 mG and the 3 mG models, the super-fast magnetosonic LISM flow passes through a critical point. Hot and fast neutral H can completely mediate a weak transition and impose a charge exchange length scale on the structure, making the solar wind - LISM interaction effectively bow shock-free. The charge exchange of fast and hot heliospheric neutral H therefore provides a primary dissipation mechanism at the weak heliospheric bow shock, in some cases effectively creating a one-shock heliosphere (i.e., a heliospheric termination shock only). We model the observed Lyman-alpha absorption profiles along the four sightlines finding that both super-fast magnetosonic models can account for the Lyman-alpha observations, with possibly the bow shock-free 3 mG model being slightly favored.

Monday, April 15: 10:55 AM - 11:20 AM
Presenter: Cummings, Alan

Voyager Observations of Energetic Particles in the Distant Heliosheath

A.C. Cummings and E.C. Stone, Caltech
B.C. Heikkila and N. Lal, Goddard Space Flight Center

The Voyager spacecraft have been exploring the heliosheath since their crossings of the solar wind termination shock on December 2004 (Voyager 1) and August 2007 (Voyager 2). Starting on 7 May 2012, dramatic short-term changes in the intensities of heliospheric particles and galactic cosmic rays have been occurring periodically at Voyager 1. In July, a series of encounters with a heliospheric depletion region occurred, culminating on 25 August 2012 with the durable entry into the region by Voyager 1 (durable at least through the time of this writing in late March 2013). This depletion region is characterized by the disappearance of particles accelerated in the heliosphere, the anomalous cosmic rays and termination shock particles; strong anisotropies of these heliospheric particles as their intensities decline; and the increased intensity of galactic cosmic ray nuclei and electrons. The result is that the low-energy part of the local interstellar galactic cosmic ray spectra is being revealed for the first time. Data from the magnetometer experiment on Voyager 1 implies that the spacecraft is not yet in the interstellar medium, but it apparently has a good connection path to it. We will report on the recent observations of energetic particles from the Voyager 1 spacecraft. This work was supported by NASA under contract NNN12AA012.

SCHEDULE OF TALKS

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Monday, April 15: 11:20 AM - 11:45 AM
Presenter: Krimigis, Stamatios

Search for the Exit: Voyager 1 at Heliosphere's Border with the Galaxy

S. M. Krimigis, R. B. Decker, E. C. Roelof, M. E. Hill, Applied Physics Laboratory, Johns Hopkins University, USA
T. P. Armstrong, Fundamental Technologies,LLC, USA
G. Gloeckler, University of Michigan, USA
D. C. Hamilton, University of Maryland, USA
L. J. Lanzerotti, New Jersey Institute of Technology, USA

We report measurements of energetic (>40 keV) charged particles on Voyager 1 (V1) from the interface region between the heliosheath (HS), dominated by solar plasma, and the local interstellar medium (LISM) expected to contain non-solar plasma and the galactic magnetic field. Particles of solar origin at V1, located at 18.5 billion km from the sun, decreased by a factor >103 on August 25, 2012, while those of galactic origin (cosmic rays) increased by 9.3% at the same time. Intensity changes appeared first for particles moving in the azimuthal direction and were followed by those moving in the radial and antiradial directions with respect to the solar radius vector. This unexpected heliospheric «depletion region» may form the interface between solar plasma and the galaxy. We suggest that one possibility for this region is an interchange instability of LISM magnetic flux tubes moving through the outer parts of the heliosheath.

Monday, April 15: 11:45 AM - 12:10 PM
Presenter: Decker, Robert

Recent Measurements of Energetic Particles from Voyager 1 in the Heliosheath Depletion Region and Voyager 2 in the Heliosheath

R. B. Decker, Johns Hopkins University, Applied Physics Lab, Laurel, MD, USA

Voyager 1 (now at 124 AU, N35 deg. lat.) has been in the heliosheath depletion region since August 2012 while Voyager 2 (now at 101 AU, S30 deg. lat.) remains in the heliosheath proper. Measurements from the Voyager 1 LECP instrument taken in the depletion region are discussed by S. M. Krimigis (this conference). In the depletion region the intensities of charged particles of evidently heliospheric origin (suprathermal ions, ACRs, low-energy electrons) decreased while those of galactic origin (GCR ions and electrons) increased, and the magnetic field intensity increased but its direction remained close to that measured in the heliosheath. Entry into the main depletion region (> 2012 doy 238) was preceded by passage through two partial depletion regions during 2012 doy 210-215 and 2012 doy 226-234. In this presentation we discuss the evolution of angular distributions of energetic ions and protons measured at Voyager 1 from mid-2012 onward. We also discuss the variations of ion and electron intensities and angular distributions measured at Voyager 2 during the same period.

SCHEDULE OF TALKS

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Monday, April 15: 1:30 PM - 1:55 PM
Presenter: Reames, Donald

What Makes Gradual SEP Events Gradual?

Donald Reames

A distinguishing characteristic of the solar energetic particles (SEPs) in “gradual” SEP events is the slow decay of particle intensities, lasting several days, in contrast with “impulsive” or 3He-rich events that come and go in hours. For many years it was thought that the slow evolution was caused by interplanetary scattering with a mean free path of ~0.1 AU, but why are the ions in impulsive events not scattered similarly? Recent years have brought increasing recognition of the importance of a “reservoir” region behind the associated shock wave and coronal mass ejection (CME) where spatially and temporally uniform population of SEPs are magnetically trapped. The spectral invariance of the trapped ions suggests minimal leakage and intensities slowly decline as the volume of the “magnetic bottle” expands with time. Thus reservoirs make gradual events gradual without the need for excessive scattering. But how can the reservoir intensities become so uniform over ~180 degrees of solar longitude when studies of compact impulsive events clearly show that ions often cannot cross to a neighboring flux tube during transit to 1 AU? What is the nature of the slow cross-field transport that uniformly distributes ions in reservoirs during the 2-3 day transit of CMEs to 1 AU?

Monday, April 15: 1:55 PM - 2:20 PM
Presenter: Cohen, Christina

The Charge-to-Mass Dependence of SEP Fluences Over Wide Longitudes

C.M.S. Cohen, Caltech, Pasadena, CA, USA
R.A. Mewaldt, Caltech, Pasadena, CA, USA
G.M. Mason, JHUAPL, Laurel, MD, USA

Accurate characterization of the transport of energetic particles throughout the inner heliosphere is important for the planning of space missions and the development and testing of space weather forecasting tools. How particles are distributed in both radius and longitude during a solar energetic particle (SEP) event has been the subject of a number of studies. Initially these studies were performed through statistical analysis of single-spacecraft measurements of many different SEP events. Later multi-spacecraft observations of individual events were examined, most notably using data from Helios and, very recently, MESSENGER. Currently by combining measurements from near-Earth spacecraft and the twin STEREO spacecraft, particle distributions can be examined as a function of longitude separately from radial dependences. Additionally, while previous studies concentrated on protons and electrons, the SEP sensors on STEREO and ACE allow heavy ions to be examined as well. Here we present the results of a study of 5 large SEP events in 2011 and 2012 that were clearly observed by both STEREOs and ACE. We have examined the event fluences and the peak intensities as a function of longitude for H, He, O and, in some cases, Fe in an effort to determine possible effects of particle charge-to-mass ratio on the longitudinal distributions. We discuss these results and their implications for the influence of particle rigidity and field line meandering on particle transport in the inner heliosphere.

SCHEDULE OF TALKS

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Monday, April 15: 2:20 PM - 2:45 PM
Presenter: Ng, Chee

Effects of the Spatial Profiles of the Solar-Wind Velocity, Magnetic Field, and Density on SEP Transport with Self-Amplified Alfven Waves

Chee K. Ng, George Mason University, USA

In large gradual solar energetic particle (SEP) events, particle transport in the inner heliosphere is greatly influenced by the self-amplification of ambient Alfven waves. The waves may grow by orders of magnitude near the shock, limiting SEP intensity energy spectrum with spectral plateau at 1 AU. The energetic protons excite an initially "traveling" wave growth that produces complex time variations of SEP abundances. Upstream wave growth is limited by the life time of the waves until they are swept downstream of the shock at Vsh – (Vsw + VA), where Vsh and Vsw are the shock velocity and solar-wind velocity relative to the Sun, VA is the Alfven velocity. Both the wave and SEP intensities maximize near the shock and fall steeply with distance upstream. The SEPs are focused by the longitudinal gradient of the magnetic field B. Furthermore, the wave growth rate depends on the momentum gradient of the SEP distribution and varies as n^(-1/2), with n the plasma proton number density. Thus the environmental quantities Vsw(r), VA(r), n(r), and B(r) (these are not independent) strongly influence the character of SEP transport. At heliocentric distance r < 8 Rs (Rs = solar radius), Vsw rises slowly from near zero on the photosphere, VA(r) peaks near 4 Rs, and n(r) deviate significantly from ~ r^(-2). I will describe a new generalized SEP transport model that takes account of not only the usual processes of wave and particle transport and self-amplification of Alfven waves but also realistic radial dependences of the above solar-wind properties, consistent with published semi-empirical solar-wind models. I will present some preliminary results and discuss their significance in relation to SEP observations.

Monday, April 15: 2:45 PM - 3:10 PM
Presenter: Mason, Glenn

Fe Enhancements In SEP Onsets: Flare/CME Mixture Or Transport Effect?

G. M. Mason(1), G. Li(2), C. M. S. Cohen(3), M. I. Desai(4), D. K. Haggerty(1), R. A. Leske(3), R. A. Mewaldt(3) and G. P. Zank(2)
(1) JHU/APL, Laurel, MD
(2) Univ. Alabama in Huntsville, Huntsville, AL
(3) Caltech, Pasadena, CA
(4) Southwest Research Institute, San Antonio, TX

During the onset phases of SEP events, the Fe/O ratio is often observed to be initially enhanced (~1) over typical SEP values, followed by a decline to values close to typical averages over entire events (Fe/O ~0.1). Two mechanisms have been suggested to explain this behavior, namely (1) a two-step process with an initial injection of "flare" particles with high Fe/O followed by shock-accelerated particles with lower Fe/O, and (2) a transport effect wherein the lower charge-to-mass ratio of Fe vs. O results in faster transport of Fe to the observer, leading to enhanced Fe/O in the early stages of the event. Distinguishing between these two scenarios is important to building a basic picture of processes taking place in large SEP events. We have carried out a detailed study of 17 large SEP events where energetic particle data was fitted by a state-of-the-art model whose computed time-intensity profiles were compared to the observed profiles of H, He, O, and Fe over a very broad energy range. We find that the observed decrease in Fe/O during the rise phase can be reasonably fitted by the transport model where the differences in Fe vs. O transport are due to the slope of the turbulence spectrum of the interplanetary magnetic field (IMF). An important additional result is that the transport model also predicts a decrease in the O/He ratio due to the different charge-to-mass ratios of O and He. This decrease is in fact also observed in the data, and is not predicted by the "flare/CME" model since surveys show no significant difference between "flare" O/He and shock-associated O/He. Although the two-step process is not ruled out by this study, the quality of the Fe/O fits along with the O/He fits arising naturally from the IMF spectrum lead us to conclude that transport is the most likely cause of Fe/O enhancements in SEP onsets.

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Monday, April 15: 3:30 PM - 3:55 PM
Presenter: Qin, Gang

The Impulsive SEP events: A Comparison of Numerical Calculation Results and Observations by Spacecraft in Different Longitude

Gang Qin
Yang Wang

Impulsive Solar Energetic Particle (SEP) events are usually produced by the solar flares. Recently, observations from different spacecraft, e.g., the STEREO A and B, and ACE, show that some impulsive events can cover a very wide longitudinal extent, so it could be assumed that SEPs can be observed on the field lines disconnected far away from the source. Therefore, it is possible that such a large longitude extent is through cross-field transport. In this work, we compare the spacecraft observations from different longitude with simulation results using a Fokker-Planck focus transport equation in three-dimensional Parker interplanetary magnetic field. So that we can investigate how SEPs propagate in the heliospheric magnetic fields.

Monday, April 15: 3:55 PM - 4:20 PM
Presenter: Mewaldt, R.A.

A 360-Degree View of Solar Energetic Particle Events

R. A. Mewaldt, Caltech
C.T. Russell, UCLA
C.M.S. Cohen, Caltech
A.B. Galvin, University of New Hampshire
R. Gomez-Herrero, University of Alcala
A. Klassen, Kiel University
R. A. Leske, Caltech
J.G. Luhmann, U.C. Berkeley
G.M. Mason, John Hopkins University, APL
T.T. von Rosenvinge, GSFC

Over the past several years it has been possible to measure Solar Energetic Particle (SEP) Events over ~360 degrees in longitude with the combination of STEREO and L1 assets like ACE. It is found that SEPs are distributed more quickly and uniformly in longitude than was appreciated based on single-point measurements. We report on a survey of large SEP events from 3 points of view as the STEREO spacecraft circle the Sun at ~22.5 degrees per year. During 2010-2012 there were 23 events at Earth that met the NOAA criterion of 10 protons/cm2sr-s with energies >10 MeV. Taking into account the STEREO data we can approximately double this number and also can identify the July 23, 2012 event as the highest-intensity SEP event so far during solar cycle 24. This event was also unusual in that the solar wind speed reached >2200 km/s, and at the time of highest SEP intensity the energetic particle pressure was greater than that of the magnetic pressure, making it a possible example of a blast wave mediated by solar energetic particles.

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Monday, April 15: 4:20 PM - 4:45 PM
Presenter: Drake, James

Multi X-line Magnetic Reconnection and Particle Acceleration

J. F. Drake, University of Maryland, USA
R. Fermo, Boston University, USA
M. Swisdak, University of Maryland

We explore magnetic reconnection and particle acceleration in a system with many interacting magnetic islands. Particle-in-cell simulations reveal that the dominant particle heating mechanism of both electrons and ions is through Fermi acceleration in contracting and merging islands and not in the current layers that form close to reconnection sites. Parker's transport equation fails to describe reconnection-driven particle acceleration because of the strong scattering assumption of the model -- the Fermi mechanism increases the parallel energy of particles and requires the development of anisotropy for efficient acceleration. Simulations also reveal that magnetic energy release and particle acceleration are limited by the approach to the marginal firehose condition as the parallel pressure of energetic particles rises. At the marginal firehose boundary magnetic fields lose the tension that drives reconnection. We develop a Parker-like transport equation that describes particle acceleration in a system with a bath of merging magnetic islands. Key ingredients to the model are the anisotropy of the spectrum of energetic particles and the self-consistent feedback of pressure anisotropy on merging dynamics. In steady state the spectra of energetic particles take the form of powerlaws. When the characteristic particle acceleration time is short compared with loss time, the approach to the marginal firehose condition controls the spectral index of the energetic particle flux, which approaches -1.5. Application of the results to solar flares, super-Alfvenic ions in the quiet solar wind and anomalous cosmic rays in the outer heliosphere are discussed.

Monday, April 15: 4:45 PM - 5:10 PM
Presenter: van der Holst, Bart

The Electron and Proton Temperature Evolution of CMEs

Bart van der Holst, University of Michigan, USA
Igor V. Sokolov, University of Michigan, USA
Ward B. Manchester IV, University of Michigan, USA
Meng Jin, University of Michigan, USA
Rona Oran, University of Michigan, USA
Tamas I. Gombosi, University of Michigan, USA

We present simulations of coronal mass ejections (CMEs) performed with a new global model of the solar corona that ranges from the upper chromosphere up to 1AU. This model accounts for the coupled thermodynamics of the electrons and protons via single fluid magnetohydrodynamics. The coronal heating and solar wind acceleration are addressed with Alfven wave turbulence. The key features of the implemented turbulence are: (1) injection of Alfven wave energy at the inner coronal boundary such that the Poynting flux is proportional to the magnetic field strength, (2) wave-energy propagation, (3) partial reflection of Alfven waves due to large-scale inhomogeneities in the coronal plasma, which leads to (4) dissipation via turbulent cascade of Alfven waves due to small-scale nonlinearities. The realistic 3D magnetic field is simulated using data from the photospheric magnetic field measurements. The model does not impose open-closed magnetic field boundaries, those naturally develop from the photospheric magnetic fields. We have performed simulations of the 2011 March 7 fast CME (> 2000 km/s) that erupted in NOAA 11164. We present a multi-spacecraft validation study of this simulated event as well as for the related ambient solar wind Carrington rotation 2107. We compare the simulated multi-wavelength EUV images with the SDO/AIA observations. The results are also compared to remote as well as in-situ observations from SOHO, STEREO A/B, ACE, and WIND. Since the thermal speed of the electrons greatly exceeds the speed of the CME, only protons are directly heated by the shock. We find that heat is able to conduct on open magnetic field lines and rapidly propagates ahead of the CME, resulting in a heat precursor of hot electrons.

SCHEDULE OF TALKS

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Monday, April 15: 5:10 PM - 5:35 PM
Presenter: Lario, David

Longitudinal Dependence of SEP Peak Intensities as Evidence of CME-Driven Shock Particle Acceleration

D. Lario, E.C. Roelof, R.B. Decker
The Johns Hopkins University. Applied Physics Laboratory

In a number of comprehensive studies (Lario et al., 2006, 2013; Dresing et al., 2012; von Rosenvinge et al., 2012; Mewaldt et al., 2011, 2012), multi-spacecraft measurements of peak intensities in the prompt component of solar energetic particle (SEP) events have been fitted by a functional form j~j0 exp[-k(ϕ-ϕ0)2], where ϕ is the difference between the heliolongitudes of the spacecraft nominal magnetic footpoints and that of the associated parent flare. The parameters k and ϕ0 are determined from the fit of the data, where k=1/2σ2 gives the Gaussian longitude spread and ϕ0 is a longitude offset with respect to the nominal well connected longitudes. Over the ensemble of events, Lario et al. (2006, 2013) obtained negative values of ϕ0 indicating that the maximum peak intensity in the prompt component of SEP events is not observed for well-connected longitudes but slightly displaced toward central meridian longitudes. If confirmed, this result has a straightforward interpretation in terms of CME-related shock acceleration in the solar corona. The point on the shock front that magnetically connects with the observer scans different portions of the shock as it propagates out from the Sun. The maximum particle injection efficiency occurs when the CME-driven shock is already at a certain distance from the solar surface. Therefore, the observer establishes magnetic connection with the strongest portions of the shock when the shock originated at a longitude located at the east of the spacecraft's footpoint. From the inferred values of ϕ0, we will estimate the helioradii where maximum SEP efficiency occurs.

Monday, April 15: 5:35 PM - 6:00 PM
Presenter: Feynman, Joan

Minima of the Centennial Gleissberg Cycles

John Feynman

N/A

Tuesday, April 16: 8:00 AM - 8:25 AM
Presenter: Gamayunov, Konstantin

Interstellar Pickup Protons and Their Effects in the Outer Heliosphere

Konstantin Gamayunov, Florida Institute of Technology, USA
Ming Zhang, Florida Institute of Technology, USA
Nikolai Pogorelov, University of Alabama in Huntsville, USA
Jacob Heerikhuisen, University of Alabama in Huntsville, USA
Hamid Rassoul, Florida Institute of Technology, USA

A self-consistent model of the interstellar pickup protons, Alfvenic turbulence, and the core solar wind (SW) heating is presented along with the initial results and comparisons with the Voyager 2 observations of the magnetic field fluctuations and SW temperature. The model is based on a set of three equations linked to the global distributions of the SW parameters and interstellar H, which are taken from the global MHD-plasma/kinetic-neutral model of the heliosphere - local interstellar medium interaction. First, we use the pickup proton kinetic equation that includes spatial transport with the SW velocity, adiabatic cooling/heating, diffusion in the velocity phase space, and a source of the pickup protons due to the charge-exchange between the interstellar H and core SW protons. Second, we utilize equation for the wave power spectral density that includes wave transport with the expanding SW, a resonant damping by the core SW protons, energy source due to isotropization of the newly born interstellar pickup protons, driving effect of the SW flow shear and/or compression, and the wave energy cascading in the wave number space due to the nonlinear wave-wave interaction. Finally, we use the core SW temperature equation that includes spatial transport, an adiabatic cooling/heating, and energy source due to the Alfven wave dissipation.

SCHEDULE OF TALKS | NOTES

Tuesday, April 16: 8:25 AM - 8:50 AM
Presenter: Livadiotis, George

Large-scale Quantization in Space Plasmas

G. Livadiotis, Soutwest Research Institute, USA
D. J. McComas, Soutwest Research Institute, USA

We identify a large-scale quantization in non-equilibrium space plasmas, h* ≈ (7.5 ± 2.4)×10^{−22} Js, using four independent methods: (1) Ulysses solar wind measurements, (2) space plasmas that typically reside in stationary states out of thermal equilibrium and spanning a broad range of physical properties, (3) an entropic limit emerging from statistical mechanics, (4) waiting-time distributions of explosive events in space plasmas. An important application of h* involves finding unknown parameter values in non-equilibrium space plasmas.

Tuesday, April 16: 8:50 AM - 9:15 AM
Presenter: Yoon, Peter

Effects of Kinetic Instabilities in the Solar Wind Modeling

Peter H. Yoon
IPST, University of Maryland, College Park
[Also at] SSR, Kyung Hee University, Korea

Among the outstanding issues involved in the solar wind modeling is the problem of how to incorporate the proton temperature anisotropy versus beta inverse correlation into the global models. As the solar wind expands outward the density and magnetic field decrease, thus leading to parallel temperature anisotropy. Perpendicular anisotropy is generated when the solar wind is compressed against the Earth's magnetosphere. The measured anisotropies near the Sun and 1 AU indicate that they do not follow the fluid model, implying that kinetic effects must be considered. For excessive perpendicular temperature anisotropy, proton cyclotron and mirror instabilities provide the collisionless dissipation, while for excessive parallel anisotropy, parallel and oblique firehose instabilities are excited. In the literature, threshold conditions for these instabilities are constructed by means of linear theory, hybrid simulation, or by observational fits. However, the actual solar wind is found in the parameter regime stable to these instabilities. Since no waves can be generated in the purely collisionless and stable plasma, the source of the low-frequency electromagnetic fluctuations in the solar wind must be owing to spontaneous thermal effects. The problem of the spontaneously emitted electromagnetic waves from magnetized plasmas is generally poorly understood. In the present paper we theoretically construct the anisotropy-beta relation by means of quasilinear theory that includes the spontaneous thermal emission of electromagnetic radiation. An excellent comparison between theory and various anisotropy-beta relations published in the literature is found, thus showing that quasilinear theory that includes the spontaneous thermal effects is a reliable tool, based upon which one may formulate a kinetic-fluid model of the solar wind.

SCHEDULE OF TALKS

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Tuesday, April 16: 9:15 AM - 9:40 AM
Presenter: Scudder, Jack

Ubiquitous Non-Thermals in Astrophysical Plasmas

J.D. Scudder
H. Karimabadi

This paper outlines the rather narrow conditions on a radiatively decoupled plasma where a Maxwell Boltzmann distribution can be assumed with confidence. The complementary non-thermal distribution with its non-zero kurtosis is argued to have a much broader purview than previously accepted. These conditions are expressed in terms of the electron Knudsen number, Ke. The sufficient condition for Spitzer-Braginskii (Maxwell-Boltzmann) plasma fluid closure at the energy equation requires globallyKe<0.01; this global condition pertains to the maximum value of Ke along the arc length s of the magnetic field (to its extremities) provided that the contiguous plasma remains uncoupled from the radiation field. The non-thermal regime is shown to be common on all main sequence stellar atmospheres above 0.05 stellar radii from the surface. The entire solar corona and wind is in this regime where non-thermal distributions with kurtosis are ubiquitous, heat flux is not well modeled by Spitzer-Braginskii closure, and fluid modeling is qualitatitve at best.

Tuesday, April 16: 9:40 AM - 10:05 AM
Presenter: Burrows, Ross

Toward Multi-scale Plasma Simulation Techniques

Ross H Burrows, UAH, CSPAR
Gary P Zank, UAH, CSPAR
Xianzhi Ao, UAH, CSPAR

The development a 'hybrid' simulation routine capable of coupling plasma physical processes across multiple scale regimes, would be useful for the study of events where large amounts of electromagnetic field energy is transferred, in short time/length scales, into kinetic energy of the particles. Such events are ubiquitous throughout space and occur e.g. during magnetic reconnection (such as is observed during magnetic storms in the magnetosphere) and at shock waves where electron/ion kinetic scale diffusion processes inject energy into the plasma and drive the physics of MHD scales. We assert that a combination of ion/electron multi-fluid and particle in cell (PIC) techniques is a viable approach and examine several results from two different codes--a two-fluid simulation and a PIC code that we have constructed with intention of combining them together into a 'hybrid'. In particular we examine ion ring-beam simulation results which could have implications for the outer heliospheric 'ribbon' observed by IBEX.

SCHEDULE OF TALKS

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Tuesday, April 16: 10:30 AM - 10:55 AM
Presenter: DeForest, Craig

Connecting the Corona and Heliosphere Through Imaging

C.E. DeForest and T.A. Howard, SwRI

Many outstanding problems in heliophysics lie in imperfect understanding of the connection between the solar corona and the solar wind. Although there is good understanding of the "zoology" of ICMEs observed in-situ and a plethora of detailed and reasonable models for how CMEs arise in the corona, connecting the two in more detail than the basic association of outbound dense structures has only recently become possible, through the bridge of quantitative heliospheric imaging. Similarly, although much is known about the structure and evolution of the slow solar wind as it propagates across the inner solar system near 1 AU and beyond, and much is known about the corona itself, there is still no clear, unambiguous understanding of the "headwaters" of the solar wind plasma in the corona, or even of why the slow solar wind itself is variable. For example, it is not clear whether the gustiness of the slow solar wind arises from variability of the source region, from variable magnetic connectivity from the solar surface, or from turbulent processing enroute. Again, wide-field heliospheric imaging is yielding new insights that complement the in-situ measurements and could help resolve these problems in the near future. We will present recent results in connecting solar wind features both large and small to their origin, using the STEREO/SECCHI instrument suite; and discuss the relevance of these results to measurements expected from upcoming missions.

Tuesday, April 16: 10:55 AM - 11:20 AM
Presenter: Galvin, Antoinette

Case Studies of Solar Wind Extremes

Kristin Simunac, University of New Hampshire, USA
Charles Farrugia, University of New Hampshire, USA

We contrast the solar wind characteristics and origins for typical and extreme cases using OMNI and STEREO data. Sources of the solar wind are known to be linked to the phase of the solar cycle and include coronal holes, coronal mass ejections, and multiple cycle-dependent sources for "slow" solar wind. This past solar minimum was characterized by weak transients and sustained periods of slow solar wind, and included cases of "slow" and "slower" solar wind stream interactions. In contrast the rise of the cycle included extremely fast interplanetary coronal mass ejections, with one such ICME observed in situ by STEREO A exceeding 1500 km/s at 1 AU. We will compare extreme cases of slow and fast solar wind observed in situ by STEREO to general solar wind ion parameters, particularly for proton, helium and iron ions.

Tuesday, April 16: 11:20 AM - 11:45 AM
Presenter: Pierrard, Viviane

A Kinetic Model of the Solar Wind

Viviane Pierrard, BISA, Belgium

The kinetic approach is used at BISA to model the solar wind. The plasma is described by the velocity distribution functions of its different particle species. The moments are obtained by integrating them over velocity space. The kinetic description may distinguish between the partial density of the electrons and different ion species, individual species bulk speeds, parallel and perpendicular temperatures, up to parallel and perpendicular heat flow tensor components or even higher moments of the underlying velocity distribution function. The existence of non-Maxwellian features in the energy spectrum of particles and asymmetries in their pitch angle distributions can be studied, as well as the effects of collisions, wave-particle interactions and turbulence. The model takes into account the solar rotation and is now extended to provide the distributions in the three dimensional space.

Tuesday, April 16: 11:45 AM - 12:10 PM
Presenter: Fuselier, Stephen

Low Energy Neutral Atoms from the Heliosheath

Representing the IBEX Science Team

In the heliosheath beyond the termination shock, low-energy (<0.5 keV) neutral atoms are created by charge exchange of ions with interstellar neutrals. The parent ion populations in this region may be shocked solar wind or low-energy pickup ions. If these neutrals are directed back into the heliosphere, then they may be detected in the inner solar system. Detecting these neutrals from Earth orbit is difficult because there is substantial charge exchange loss as the neutrals propagate from >100 AU to 1 AU and because there are a variety of other signal and background sources that compete with this weak signal. The IBEX-Lo sensor was designed to detect neutral atoms with energies from 0.01 to 2 keV from the heliosheath and the interstellar medium. This talk reviews IBEX-Lo measurement strategies for low-energy heliosheath neutrals. Using several of measurement strategies, these neutrals are distinguished from other signals and backgrounds and a definitive energy spectrum for these neutrals is developed. Implications for the low energy fluxes on processes in the heliosheath are discussed.

SCHEDULE OF TALKS

NOTES

Tuesday, April 16: 1:30 PM - 1:55 PM
Presenter: Poedts, Stefaan

A New Paradigm for Solar Coronal Heating

J. Vranjes and S. Poedts
KU Leuven, Dept. of Mathematics, Center for mathematical Plasma Astrophysics (CmPA), and Leuven Mathematical Modeling and Computational Science Center (LMCC), Belgium

The solar coronal heating problem refers to the question why the temperature of the Sun's corona is more than two orders of magnitude higher than that of its surface. Almost 70 years after the discovery, this puzzle is still one of the major challenges in astrophysics. A self-consistent coronal heating model must fulfill a lot of requirements imposed by observational facts. First of all, it should be consistent with the measured energy losses in the solar corona due to conduction and radiation, i.e. it should a) not only provide the right amount of energy but b) do so at the right times scales, e.g. ▯ 10-4 J/(m s) in active regions. Moreover, it should c) include the source of the required energy, and d) work everywhere in the corona, i.e. for all different magnetic structures (with different heating requirements). Furthermore, it should be able e) to explain the observed temperature anisotropy (T⊥ > T▯), f) be more effective on ions than on electrons (Ti > Te), and g) heat heavier ions more efficiently than lighter ions. None of the proposed heating mechanisms so far even claimed to fulfill all these model requirements. The current paradigm of coronal heating states that the required energy source is provided by the plasma flows below the solar surface and that this energy is transferred to the corona through the motions of the `foot points' of the coronal magnetic field lines which are `anchored' in this zone. Depending on the ratio τ of the time scale of these 'driving' motions to the dynamic (Alfvén) time scale, the current models are classified as 'wave heating' (τ < 1) or 'magnetic reconnection (or nanoflare)' (τ > 1) models. The main challenge, however, is to explain how the energy is dissipated in the highly conductive corona with a Lundquist number (the ratio of the dissipation time to the Alfvén time scale) around 1013. All proposed mechanisms either have a problem with the energy transport to the corona (the observed wave fluxes are too small) or with the dissipation (too little and/or too slow, or only sporadic). Most current models rely on the continuum or fluid approximation (Magnetohydrodynamics, MHD). However, these models cannot really explain coronal heating completely because i) it is clear that the actual heating takes place at length scales much smaller than those on which the (macroscopic) MHD model is justified; and ii) it is obvious that the observed discrepancy between ion and electron temperatures in the corona, as well as iii) the observed large temperature anisotropy in the inner corona (T⊥ > T▯) and iv) the observed preferential heating of the heavier ions are beyond the (single!) fluid model. We argue that a new paradigm is required to solve the puzzle in a self-consistent manner. The alternative approach is based on the kinetic theory of drift waves. We show, with qualitative and quantitative arguments, that the drift waves have the potential to satisfy all coronal heating requirements. Hence, the basic ingredient necessary for the heating is the presence of density gradients in the direction perpendicular to the magnetic field vector. Such density gradients are a source of free energy for the excitation of drift waves. We use only well-established basic theory, verified experimentally in laboratory plasmas. Two mechanisms of the energy exchange and heating are shown to take place simultaneously: one due to the Landau effect in the direction parallel to the magnetic field, and another one, stochastic heating, in the perpendicular direction. The stochastic heating i) is due to the electrostatic nature of the waves, ii) is more effective on ions than on electrons, iii) acts predominantly in the perpendicular direction, iv) heats heavy ions more efficiently than lighter ions, and v) may easily provide a drift wave heating rate that is orders of magnitude above the value that is presently believed to be sufficient for the coronal heating, i.e., ▯ 6̃ 10-5 J/(m s) for active regions and ▯ 8̃ 10-6 J/(m s) for coronal holes. This heating acts naturally through well-known effects that are, however, beyond the current standard models and theories.

SCHEDULE OF TALKS

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Tuesday, April 16: 1:55 PM - 2:20 PM
Presenter: Raymond, John

Probing the Solar Corona with Comet Lovejoy

J. Raymond, CfA
P. McCauley, CfA
S. Saar, CfA
C. Downs, PSI

In December 2011 a 500 meter ball of ice and dust passed just 0.2 solar radii above the surface of the Sun. It was observed with UVCS/SOHO between 2 and 10 solar radii during its approach and by AIA/SDO. As it deposited gas and dust along its path, it provided a probe of density and temperature in the corona along with the comet outgassing rate and composition. We discuss the the interaction between gas from the comet and the solar wind near the current sheet between 6 and 8 Rsun, along with the interaction in the inner corona.

Tuesday, April 16: 2:20 PM - 2:45 PM
Presenter: Song, Paul

A Model of the Chromosphere: Heating, Structures, and Circulation

P. Song Center for Atmospheric Research and Department of Physics, University of Massachusetts Lowell
V. M. Vasyliūnas, Center for Atmospheric Research and Department of Physics, University of Massachusetts Lowell, and
Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau, Germany

We propose a model of local cicrculation in the chromosphere, with scale size of supergranules. The strong heating required in order to balance the radiative losses in the chromosphere is provided by strong damping, through plasma-neutral collisions, of Alfvén waves that are driven by motions below the photosphere. On the basis of a self-consistent plasma-neutral-electromagnetic one-dimensional model, we derive the vertical profile of wave spectrum and power by a novel method, including the damping effect neglected in previous treatments. The high-frequency portion of the source power spectrum is strongly damped at lower altitudes, whereas the lower-frequency perturbations are nearly undamped and can be observed in the corona and above. As a result, the waves observed above the corona constitute only a fraction of those at the photosphere and, contrary to supposition in some earlier Alfvén-wave-damping models, their power does not represent the energy input. Calculated from parameters of a semi-empirical model for quiet-Sun conditions, the mechanism can generate sufficient heat to account for the radiative losses in the atmosphere, with most of the heat deposited at lower altitudes. When the magnetic field strength varies horizontally, the heating is likewise horizontally nonuniform. Since radiative loss is a strong function of temperature, the equilibrium temperature corresponding to local thermal balance between heating and radiation can be reached rapidly. Regions of stronger heating thus maintain higher temperatures and vice versa. The resulting uneven distribution of temperature drives chromospheric circulation, which produces a temperature minimum in the chromosphere near 600 km altitude and distorts the magnetic field to create a funnel-canopy-shaped magnetic geometry, with a strong field highly concentrated into small areas in the lower chromosphere and a relatively uniform field in the upper chromosphere. The formation of the transition region, corona, and spicules will be discussed.

SCHEDULE OF TALKS | NOTES

Tuesday, April 16: 2:45 PM - 3:10 PM
Presenter: Cooper, John

Solar Occultation Explorer (SOX)

John F. Cooper, NASA Goddard Space Flight Center, U.S.A.
Shadia R. Habbal, University of Hawaii at Manoa, U.S.A.
Adrian N. Daw, NASA Goddard Space Flight Center, U.S.A.
Edward C. Sittler Jr., NASA Goddard Space Flight Center, U.S.A.
Eric R. Christian, NASA Goddard Space Flight Center, U.S.A.
Nathan Schwadron, University of New Hampshire, U.S.A.

The Moon has long served as an essential enabler of ground-based solar coronal observations at visible wavelengths, broadband for high spatial resolution of inner coronal structures and narrow-band for high spectral resolution of coronal excitation emission lines that illuminate the origins and evolution of solar wind heating and acceleration. The extremely tenuous lunar atmosphere allows a very sharp cutoff of the solar disk at the lunar limb for coronal observations, although ground-based observers must of course contend with viewing through the Earth's atmosphere which limits brightness and spatial resolution for the semi-annual opportunities of solar eclipse observations. The immensely bright background of the visible solar disk can be removed by occulting systems onboard spacecraft far above the atmosphere but such a system of equivalent efficiency to the lunar limb would be technically challenging and expensive. Orbits of the ongoing twin-spacecraft ARTEMIS lunar mission suggest an alternative approach, far more frequent quasi-daily observations of the limb-eclipsed Sun from lunar orbit. If instrumented with a visible spectral imaging telescope equivalent to the SOHO LASCO C1 spectrometer, long since inoperable on SOHO, the suggested Solar Occultation Explorer (SOX) could view the corona nearly continuously at moderate spatial and brightness resolution with an internal occulter system and periodically at unprecedentedly high resolution during limb eclipse intervals. If operational during the 2018 – 2024 epoch of Solar Probe Plus in-situ measurements into 10 – 30 Rsun of the outer corona, SOX could potentially map inner coronal structures and kinetic distributions outward into the coronal domain accessible to SPP. In-situ measurements of plasma and energetic ion composition on both spacecraft could additionally connect the coronal source and geospace regions of solar ions for investigation of inner heliospheric propagation. Enabling precursors to SOX include the ongoing Lunar Reconnaissance Orbiter mission for precision mapping of lunar limb topography and the upcoming Lunar Atmosphere and Dust Environment Explorer (LADEE) for in-situ exploration of the sunlight-scattering lunar neutral gas and dust environments. SOX could furthermore provide a missing element of all lunar science missions to date, high mass resolution measurements of lunar exospheric ion composition at low charge state that could easily be separated from high-charge-state abundances of solar wind ions. In the aftermath of the recent Chelyabinsk meteor strike, we also point out the advantage of the relatively low-cost SOX orbital approach for detection of potentially hazardous asteroidal or cometary objects coming from near-sunward directions. New limits might also be placed on the yet-undetected but long fabled population of vulcanoids in near-solar orbits. Initial concept study for SOX is currently supported by the NASA Lunar Advanced Science and Exploration Research (LASER) program as a mission application study of the Lunar Solar Origins Exploration (LunaSOX) project at NASA Goddard Space Flight Center.

Tuesday, April 16: 3:30 PM - 3:55 PM
Presenter: Matsumoto, Takuma

Alfven wave heating and acceleration above an open flux tube

Takuma Matsumoto, Nagoya University, Japan
Takeru K. Suzuki, Nagoya University, Japan

We have performed a 2.5 dimensional magnetohydrodynamic simulation describing the propagation and dissipation of Alfven waves in the solar atmosphere. Energy injection by means of Alfven waves from the photosphere results in the hot corona and the high speed solar wind. The purpose of this study is to describe the detailed results and the analysis method. These results include the dynamics of the transition region and the precisely measured heating rate in the atmosphere. Particularly, the spatial distribution of the heating rate helps us to interpret the actual heating mechanisms in the numerical simulation.

SCHEDULE OF TALKS

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Tuesday, April 16: 3:55 PM - 4:20 PM
Presenter: Ruzmaikin, Alexander

The Centennial Gleissberg Cycle.

Joan Feynman, Helio Research, USA
Alexander Ruzmaikin, Jet Propulsion Laboratory, California Institute of Technology, USA

The Centennial Gleissberg Cycle (CGC) is a 90-100 year variation in the solar wind properties implied from geomagnetic activity and caused by a systematic variation of the 11-year cycle of solar activity. In contrast, a Maunder-type Grand Minimum consists of decades during which the 11-year cycle is missing or strongly depressed. We show that the recent deep decline in solar activity has the characteristics of the CGC minimum and does not presage the entrance into a new Maunder-type Grand Minimum. The CGC is shown to exist in solar output data 80% of the time during the last 1,500 year and therefore is a real quasi-periodic solar variation. In this talk we will discuss the observational evidence of the CGC, its origin in the solar dynamo, and its forcing effect on the Earth's climate.

Tuesday, April 16: 4:20 PM - 4:45 PM
Presenter: Schwadron, Nathan

Retention of Ions Producing the IBEX Ribbon

N. A. Schwadron, University of New Hampshire
D. J. McComas, SWRI

The Ribbon Observed by the Interstellar Boundary Explorer (IBEX) Mission is a narrow, ~20 deg wide feature that stretches across much of the sky in the global flux of energetic neutral atoms from the outer heliosphere. The ribbon remains an enigma despite its persistence after 3 years of IBEX observations and after almost a dozen theories that attempt to explain it. While each theory that has been posed has its strengths, each one also contradicts IBEX observations or demonstrates significant flaws in internal consistency. Here, we present a new theory that is different than any of the existing ideas and yet accounts for many of the key observations. We argue that the ribbon could be produced by a spatial region in the local interstellar medium where newly ionized atoms are temporarily contained through increased rates of scattering by locally generated waves in the electromagnetic fields. The particles in the ribbon are created predominantly from neutralized solar wind and neutralized pickup ions from inside the solar wind termination shock. In addition to presenting the new retention theory, we discuss astrophysical implications of this theory and the Ribbon for our understanding the local interstellar magnetic field and galactic magnetic fields in general.

Tuesday, April 16: 4:45 PM - 5:10 PM
Presenter: Swisdak, Marc

A Porous, Layered Heliopause

M. Swisdak, University of Maryland, USA
J. F. Drake, University of Maryland, USA
M. Opher, Boston University, USA

The picture of the heliopause (HP) – the boundary between the domains of the sun and the local interstellar medium (LISM) – as a pristine interface fails to describe recent Voyager 1 spacecraft data. Particle-in-cell simulations reveal that the sectored region of the heliosheath (HS) produces large-scale magnetic islands that reconnect with the interstellar magnetic field and mix the LISM and HS plasma. Cuts across the simulation data reveal multiple, anti-correlated jumps in the number densities of LISM and HS particles at the magnetic separatrices of the islands, similar to those observed by Voyager 1. A model is presented, based on both the observations and simulation data, of the HP as a porous, multi-layered structure threaded by magnetic fields.

SCHEDULE OF TALKS

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Tuesday, April 16: 5:10 PM - 5:35 PM
Presenter: Ng, Chung-Sang

Distribution of Nanoflares as Spatially Resolved Current Sheets in the Solar Corona

L. Lin, Space Science Center, University of New Hampshire, 39 College Road, Durham, NH, USA
C. S. Ng, Geophysical Institute, University of Alaska Fairbanks, PO Box 757320, Fairbanks, AK, USA

In a recent numerical study [Ng et al., Astrophys. J. 747 109, 2012], based on a three-dimensional model of coronal heating using reduced magnetohydrodynamics, we have obtained scaling results of heating rate versus Lundquist number S based on a series of runs in which random photospheric motions are imposed for hundreds to thousands of Alfvén time in order to obtain converged statistical values. The heating rate found in these simulations saturates to a level that is independent of S in the high S limit and is consistent with the required level for coronal heating. In a previous study based on the total heating rate time series in these simulations, we have also calculated heating events distributions, which are consistent with observations but do not support the nanoflares scenario [Parker, Astrophys. J. 330, 474, 1988]. This method has a limitation of not distinguishing individual heating events. We now extend this analysis to investigate the distribution of energy release events defined as spatially resolved current sheets. We report preliminary results and compare to results obtained using only time-series analysis. This work is supported by NASA grants NNX08BA71G, NNX06AC19G, a NSF grant AGS-0962477, and a DOE grant DE-FG02-07ER54832.

Tuesday, April 16: 5:35 PM - 6:00 PM
Presenter: Gopalswamy, Nat

Source Regions of Ground Level Enhancement Events

N. Gopalswamy, H. Xie, S. Akiyama, S.Yashiro

Ground level enhancement (GLE) in solar energetic particle (SEP) events represent the highest energy (~GeV) particles accelerated during large solar eruptions. GLEs are thought to be accelerated by flare and shock processes. Extensive CME observations in association with GLEs that became available during solar cycle 23 suggest that shocks form very close to the Sun and that the shocks have sufficient time to accelerate GeV particles. In this paper, I present additional evidence in support of the shock acceleration mechanism. The first GLE event of solar cycle 24 (on May 17, 2012) was associated with only an M-class flare, but the CME was very fast (~2000 km/s). There were several eruptions in the longitude range of the GLE event that had larger flares and faster CMEs, but they lacked GLEs. It was found that in the non-GLE events, the latitudinal distance of the source region to the ecliptic was much larger than that in cycle 23 GLE events. The increased latitudinal distance from the ecliptic is caused by the non-radial motion of the CMEs and the unfavorable solar B-angle. This suggests that the magnetic connectivity of the shock nose is important in deciding whether a solar energetic particle event is observed as a GLE event. Thus, GLE events seem to require special conditions in terms of CME kinematics, coronal environment, and the magnetic connectivity of the solar source to an Earth observer. Work supported by NASA's Living with a Star program.

Wednesday, April 17: 8:00 AM - 8:25 AM
Presenter: Zhao, Liang

In-situ Comparison of Polar-coronal-hole and Equatorial-coronal-hole wind at solar minima and solar maximum: ACE and Ulysses observations

Liang Zhao, University of Michigan, Ann Arbor, USA
Enrico Landi, University of Michigan, Ann Arbor, USA

Coronal-hole associated, fast wind can be accelerated from two different sources: polar coronal holes (PCH,|lat|>70°) and equatorial coronal holes (ECH, |lat|<20°). Little is known about the relationship between the wind coming from these two different latitudes, and whether these two sub-categories of wind evolve in the same way along the solar cycle. Ulysses 19-year observations from 1990 to 2009 combined with ACE observations from 1998 to present provide us with in-situ measurements of solar wind properties that span two entire solar cycles. These missions allow us to study the evolution of the properties of the solar wind as a function of latitude and provide an ideal dataset to study the fast wind coming from equatorial and polar holes. Also, Ulysses and ACE observations allow us to study the changes occurred in all types of solar wind as a consequence of the exceptionally low activity of the Sun in solar cycle 24. In this work, we focused on the evolution and properties of the PCH and ECH solar wind during the minima of solar cycle 23 and 24. We use data from SWICS, SWOOPS, VHM/FGM on board Ulysses, and SWICS, SWEPAM, and MAG on board ACE to analyze the dynamic, composition, and magnetic field properties of the PCH wind and ECH wind, with a special focus on their differences during solar minima of cycles 23 and 24. To complete our comparison, we also include the streamer-associated wind (ST wind) as a reference. The comparison of PCH, ECH and ST wind shows that: 1) the kinetic, compositional and magnetic properties of ECH wind and PCH are significantly different at any time during the solar cycle, and 2) the two types of solar wind respond differently to the changes in solar activity from cycle 23 to cycle 24. Also, the properties of the ST winds change in yet a different way from those of the two types of fast wind. We discuss the implications of these results, and relate them to remote sensing measurements of the properties of streamers and polar and equatorial coronal holes carried out during the minima of cycles 23 and 24.

Wednesday, April 17: 8:25 AM - 8:50 AM
Presenter: Leske, Richard

Observations of Loss Cone Pitch Angle Distributions of Solar Energetic Particles

R.A. Leske, A.C. Cummings, C.M.S. Cohen, R.A. Mewaldt, A.W. Labrador, E.C. Stone, Caltech, Pasadena, CA USA
M.E. Wiedenbeck, JPL/Caltech, Pasadena, CA USA
E.R. Christian, T.T. von Rosenvinge, NASA/GSFC, Greenbelt, MD USA

The Low Energy Telescopes (LETs) onboard the twin STEREO spacecraft can measure the anisotropies of energetic particles for protons through iron at energies of 4-12 MeV/nucleon. Large unidirectional anisotropies often appear at the onset of magnetically well-connected solar energetic particle (SEP) events due to beamed particles undergoing relatively little scattering. Long-lasting bidirectional flows are seen within interplanetary coronal mass ejections (ICMEs) during the decay phase of several SEP events, probably due to either injection of particles at both footpoints of the CME or mirroring of a unidirectional beam. Mirroring clearly occurs in several cases that show a loss cone distribution, in which particles with large pitch angles are reflected while those with smaller pitch angles are not. The loss cone width provides information on the magnetic field strength at the mirroring point far from the spacecraft, while timing differences (if detectable) between outgoing and mirrored particles may help constrain the location of the reflecting boundary. In some instances, the shape of the distribution varies with energy and species, and comparison with theory may be used to determine the rigidity dependence of the diffusion coefficient. We present some of the more interesting LET anisotropy observations throughout the STEREO mission to date and discuss the implications of these observations for SEP transport in the heliosphere.

SCHEDULE OF TALKS | NOTES

Wednesday, April 17: 8:50 AM - 9:15 AM
Presenter: Wiedenbeck, Mark

The Interplanetary Population of Suprathermal Ions from Impulsive Solar Energetic Particle Events: Solar Cycle Variations

M. E. Wiedenbeck, Caltech, USA
G. M. Mason, JHU APL, USA

One of the key advances in the understanding of the origin of large solar energetic particle (SEP) events was the realization that acceleration efficiency can be significantly enhanced due to the presence of a population of suprathermal ions in the medium from which an interplanetary shock is accelerating particles. Impulsive SEP events provide a source of interplanetary suprathermals that can be distinguished on the basis of ion composition since these events are characterized by large enhancements of the abundance ratios 3He/4He and Fe/O, among others. Using composition measurements made using ACE and STEREO between 1997 and 2013 we will report on the solar cycle variation of suprathermals from impulsive events over more than a full solar cycle. We will also discuss the significance of variations for the contribution of SEPs to the interplanetary radiation environment.

Wednesday, April 17: 9:15 AM - 9:40 AM
Presenter: Lepri, Susan

The Behavior of Solar Wind Heavy Ions During Solar Cycle 23

Susan T. Lepri, University of Michigan, USA
Enrico Landi, University of Michigan, USA
Thomas H. Zurbuchen, University of Michigan, USA

Solar wind plasma and compositional properties reflect the physical properties of the corona and its evolution over time. Studies comparing the previous solar minimum with the most recent, unusual solar minimum indicate that significant environmental changes are occurring globally on the Sun. In this work we analyze the compositional changes of the solar wind during cycle 23 from 2000 to 2010 while the Sun moved from solar maximum to solar minimum. We find a systematic change towards lower ionization states and decreases of nearly a factor of two for heavy ion abundances (He, C, O, Si, and Fe) relative to H as the Sun went from solar maximum to solar minimum. We discuss these results and their implications for models of the evolution of the solar atmosphere, and for the identification of the fast and slow wind.

Wednesday, April 17: 9:40 AM - 10:05 AM
Presenter: Gloeckler, George

Supersonic Solar Wind Jets Surrounding the Heliosphere

G. Gloeckler, University of Michigan, Ann Arbor USA
L. A. Fisk, University of Michigan, Ann Arbor USA

The Voyager spacecraft are currently exploring the interface between the LISM and the heliosphere in the nose region, and Voyager 1, which is closest to the interface, is observing phenomena that were unexpected and profoundly interesting: there is a sudden decrease in the intensity of particles that are accelerated in the outer heliosphere and easy access of galactic cosmic rays. Yet there is no evidence that Voyager 1 has passed out of the heliosphere into the LISM. We will present our model for the outer heliosphere that can account for the Voyager 1 observations, and predict that there must be jets of supersonic solar wind along the interface between the heliosphere and the LISM. Although the motion of the Sun relative to the LISM is only ~26 km/s, the nose region of the heliosphere is surrounded by jets of solar wind with speeds of several hundred km/s flowing opposite to the direction of motion of the Sun through the local interstellar medium.

SCHEDULE OF TALKS

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Wednesday, April 17: 10:30 AM - 10:55 AM
Presenter: Elliott, Heather A.

New Horizons Solar Wind Around Pluto (SWAP) Solar Wind Measurements from 5 to 23 AU

Heather A. Elliott, David J. McComas, Joey Mukherjee, Philip Valek, Peter A. Delamere, and Fran Bagenal

The Solar Wind Around Pluto (SWAP) instrument on the New Horizons (NH) spacecraft has collected and received solar wind measurements from 5 to 23 AU, and another 230 days of hibernation data are scheduled to be downlinked this April. Although the SWAP instrument is simple in design, this simplicity adds complexity to the analysis of the measurements. In this presentation we describe key aspects of the instrument calibration necessary to obtain accurate solar wind parameters. Most of the solar wind observations are collected while spinning (12 sec period). The SWAP instrument performs a 64 step coarse scan over the full energy range followed by another 64 fine scan centered on the step with the peak rate during the coarse scan. The pair of scans takes 64 seconds, and each step has a 390 msec accumulation time. At every step ions from the full field-of-view (10 by 276°) are focused onto a pair of coincidence Channel Electron Multipliers (CEMs). The instrument sensitivity varies across the FOV, and the energy and range of energies observed depends on the angle at which the ions enter. We developed a simple analytic expression for the count rates, which neglects such angle dependences, but runs quickly. Recently, we developed a more comprehensive model that runs slower, but reproduces the spin variation due to the angle dependences in the instrument response. For the new method, we show 3 examples at 11.22, 18.31 and 23.21 AU. We will use the new technique to examine recent measurements at 23.8 AU. In these new measurements there is a clear rarefaction with a decreasing speed profile is followed by an increase in the speed forming a wave or shock. We will examine the solar wind and pickup ions to determine if the solar wind temperature speed relationship for this compression is different than what is observed in the inner heliosphere.

Wednesday, April 17: 10:55 AM - 11:20 AM
Presenter: Coates, Andrew

Surprises from Saturn - and implications for other environments

Andrew J. Coates, Mullard Space Science Laboratory, University College London, UK

The Cassini mission at Saturn has provided many surprises on Saturn's rapidly rotating magnetosphere and its interaction with the diverse moons, as well as its interaction with the solar wind. Enceladus, orbiting at 4 Rs, was found to have plumes of water vapour and ice which are the dominant source for the inner magnetosphere. Charged water clusters, charged dust and photoelectrons provide key populations in the 'dusty plasma' seen here, direct pickup is seen near Enceladus and field aligned currents create a spot in Saturn's aurora. At Titan, orbiting at 20 Rs, heavy negative and positive ions are seen in the ionosphere, which provide the source for Titan's haze. Ionospheric plasma is seen in Titan's tail, enabling ion escape to be estimated at 7 tonnes per day. Saturn's ring ionosphere was seen early in the mission and a return will be made in 2017. In addition, highly accelerated electrons are seen at Saturn's high Mach number bow shock. Here we review some of the key new results, and discuss the implications for other solar system contexts.

SCHEDULE OF TALKS

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Wednesday, April 17: 11:20 AM - 11:45 AM
Presenter: McKenna-Lawlor, S.

The Scientific Objectives of ESA's Comet Orbiter ROSETTA and Lander PHILAE

S.McKenna-Lawlor, Space Technology Ireland, Maynooth, Kildare, Ireland
Gerhard Schwehm, Space Science Dept., ESA-ESTEC, Noordwijk, The Netherlands
Rita Schulz, Space Science Dept., ESA-ESTEC, Noordwijk, The Netherlands
Stephan Ulamec, German Aerospace Center (DLR), Linder Höhe, Köln, Germany

Comets are probably the most primitive bodies in the Solar System and their low degree of evolution can potentially provide unique information about the characteristics of the nebula from which the Sun and planets formed. In addition, comets are carriers of complex organic molecules that can be delivered to Earth through impacts, and which, thereby, may have played a role in the origin of terrestrial life. Further, volatile light elements carried by comets may have contributed to forming the Earth's oceans and atmosphere. Rosetta is the first mission designed to orbit and land on a comet (67P/Churyumov-Gerasimenko) The Rosetta spacecraft will first orbit this comet and deliver a lander (Philae) to its surface while located at a distance of about 3 AU from the Sun. The spacecraft will then continue to orbit and map the comet as it approaches closer to the Sun, observing in detail how it becomes gradually more active and how its interaction with the solar wind develops. Once perihelion is passed, the spacecraft will continue to orbit and observe the comet out to 2 AU. Philae will determine the physical properties of the comet's surface and subsurface and their chemical, mineralogical and isotopic composition, thereby complementing studies carried out aboard the orbiter of the overall characterisation of the comet's dynamic properties and surface morphology. In this presentation, the scientific objectives addressed by 12 instruments carried aboard the orbiter and 10 aboard the lander will be described.

Wednesday, April 17: 11:45 AM - 12:10 PM
Presenter: Adhikari, Laxman

Turbulence Transport Model Applied to Space Physics And Astrophysics

L. Adhikari , University of Alabama in Huntsville, USA
G. Zank , University of Alabama in Huntsville, USA
Q. Hu , University of Alabama in Huntsville, USA
A. Dosch, University of Alabama in Huntsville, USA

Understanding the evolution of low-frequency MHD turbulence throughout the heliosphere is critical to understanding the large-scale heating of the solar wind, the modulation of energetic particles, and so forth. Zank et al 1996 derived a turbulence transport model describing the heliocentric evolution of the magnetic field fluctuation variance and compared steady-state solutions to Voyager 1 and 2 and Pioneer 11 data, finding good agreement from 1 AU to ~40 AU. Such comparisons have been extended in numerous follow-up studies, including Smith et al., 2001, finding similar good agreement with models. Despite the observations being made over several solar cycles, all previous studies have used a steady-state solution to the turbulence transport equations. In this work, we assume that the solar wind properties vary with solar cycle. This introduces a variable solar wind convection speed and timedependent source terms and inner boundary conditions. The time dependent 1D turbulence transport equations of magnetic energy density and correlation length throughout the heliosphere are solved using an explicit finite difference scheme. The energy densities and correlation lengths are calculated at the Voyager 2 positions assuming solar cycle variability. To illustrate the impact of a solar cycle varying wind, three different models are considered: Undriven Models, Stream-Interaction Driven Models, and Pickup Ion Driven Models. Finally, the full model with all appropriate sources of turbulence is considered. The corresponding observed magnetic field fluctuation energy densities are calculated from the Voyager 2 data, and a comparison with the model is made.

SCHEDULE OF TALKS

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Wednesday, April 17: 1:30 PM - 1:55 PM
Presenter: Li, Bo

Differences in Solar Wind Parameters Measured during the Cycle 23-24 and 22-23 Minima help tell what Turbulence-based Mechanisms heat the Solar Wind

Bo Li, School of Space Science & Physics, Shandong University at Weihai, China

The solar wind acceleration is closely related to its heating. While turbulence is commonly accepted to be at the heart of solar wind heating mechanisms, considerable debate exists as to exactly how it works. At present there are two main competing ideas. One is based on the cyclotron resonance between ions and high frequency waves generated by a parallel cascade, while the other, developed only most recently, is based on the interaction of solar wind species with reflection-driven turbulence where the cascade proceeds primarily in the perpendicular direction. Both scenarios can yield model parameters that agree with a large number of observations, especially those obtained at the previous solar minimum, hence making it difficult to tell which mechanism works better. In this contribution we demonstrate that in addition to the absolute values of wind parameters measured at a given solar minimum, the relative changes from one minimum to another can help to achieve this objective. To be specific, we compute a grid of multifluid, turbulence-based solar wind models where electrons and protons are distinguished, the proton temperature anisotropy is considered, and relatively complete energy equations are used for both species. The models employ the two primary competing ideas for solar wind heating. In each group of models, we construct solutions using magnetic field parameters appropriate for either the 23-24 or the 22-23 minimum. The differences in the obtained wind parameters from one minimum to the other are then compared with the in situ measurements, thereby helping us identify which mechanism performs better.

Wednesday, April 17: 1:55 PM - 2:20 PM
Presenter: Boldyrev, Stanislav

The Physics of Subproton Turbulence in Astrophysical Plasmas

S. Boldyrev, K. Horaites, Q. Xia, J. C. Perez

Recent high-resolution observations of the solar wind revealed the presence of significant magnetic, density, and electric fluctuations at scales smaller than ion gyroscale, often referred to as dispersion or dissipation scales. We discuss subproton plasma turbulence, specifically concentrating on the role of kinetic-Alfven and whistler modes and revealing their common characteristics as well as essential physical differences. The results are useful for formulation of phenomenological models and interpretation of observational data.

Wednesday, April 17: 2:20 PM - 2:45 PM
Presenter: De Koning, Curt

Getting under the skin of a CME

N/A

N/A

SCHEDULE OF TALKS

NOTES

Wednesday, April 17: 2:45 PM - 3:10 PM
Presenter: Wan, Minping

Intermittency and Dissipation in MHD and Plasma Turbulence

Minping Wan, University of Delaware, USA

MHD simulations as well as solar wind magnetic field observations show the formation of internal boundaries, characteristic coherent structures, and organization into flux tubes and/or regions with characteristic correlations. Recently evidence is accumulating that these structures are a manifestation of turbulence intermittency. Here we review some of our recent works on the study of intermittency and dissipation in MHD and plasma turbulence. With high resolution kinetic simulations of collisionless plasma driven by shear, we show the development of turbulence characterized by dynamic coherent sheet-like current density structures spanning a range of scales down to electron scales. We present evidence that these structures are sites for heating and dissipation, and that stronger current structures signify higher dissipation rates. Evidently, kinetic scale plasma, like MHD, becomes intermittent due to current sheet formation, leading to the expectation that heating and dissipation in astrophysical and space plasmas may be highly non-uniform and patchy. We also compare high-resolution spacecraft observations with both MHD and kinetic plasma simulations to facilitate the interpretation of signatures of various dissipation mechanisms. Kurtosis of increments indicates that kinetic scale coherent structures are present. Conditioned proton temperature distributions suggest heating associated with coherent structures. These results reinforce the association of intermittent turbulence, coherent structures, and plasma dissipation.

Wednesday, April 17: 3:30 PM - 3:55 PM
Presenter: Scime, Earl

Sources of Complex Ion Velocity Distributions in the Laboratory, in Space, and in Simulations

Earl Scime
Jerry Carr Jr.
Matthew Galante
Richard Magee, West Virginia University
Martin Goldman
David Newman, University of Colorado-Boulder
J. P. Eastwood, Imperial College

We present evidence for the formation of multiple double layers within a single divergent magnetic field structure. Downstream of the divergent magnetic field, multiple accelerated ion populations are observed. The similarity of the accelerated ion populations observed in these laboratory experiments to ion populations observed in reconnection outflow regions in the magnetosphere and in numerical simulations is also described. If ion energization during magnetic reconnection also results from acceleration in electric fields, these observations suggest that complex velocity distribution structures could be misinterpreted as evidence of ion heating.

Wednesday, April 17: 3:55 PM - 4:20 PM
Presenter: Kharchenko, Vasili

ENA Transport and Energy Relaxation in the Interstellar Medium

Vasili Kharchenko (1,2) and Nicholas Lewkow (1,2)
(1) Harvard-Smithsonian Center for Astrophysics
(2) Physics Department, University of Connecticut

The solar and stellar winds, interacting with the neutral interstellar and atmospheric gases, produce Energetic Neutral Atoms (ENAs), which can travel very long distances in the interstellar medium. These nascent ENAs will be finally termalized after a large number of momentum-energy and charge-transfer collisions. The “termalization length” for ENAs with energies of several keV/amu may reach a value of hundreds of light-years and because of that, thousands of stars can contribute into the low-energy part of the local diffuse ENA distribution. We report results of our Monte Carlo (MC) simulations of the ENA energy relaxation and transport in the interstellar medium. Accurate differential and total cross sections, required for a description of the momentum-energy transfer in collisions of H and He energetic atoms and their isotopes, have been obtained in ab initio quantum mechanical calculations for the broad energy interval from 0.1eV to 10keV. Theoretical angular- and energy-dependent cross sections have been verified with the available experimental results. With these cross sections, the ENA distribution functions have been computed as functions of the distance from the ENA source star. Using results of our Monte Carlo simulations, we have evaluated the diffuse ENA distributions of He, H, and O atoms in vicinity of the heliosphere. Energy spectra of the He and H ENA distributions and their dependence on the parameters of stars in the solar neighborhood have been analyzed.

Wednesday, April 17: 4:20 PM - 4:45 PM
Presenter: Mazelle, Christian

Influence of Nonstationary Dynamics of Collisionless Shock Front on Particle Reflection and Acceleration

Christian Mazelle, IRAP, CNRS - Univ. Toulouse, France
Bertrand Lembege, LATMOS, CNRS - UVSQ, France
Karim Meziane, Dept. Physics, UNB, Canada

Results from multi-spacecraft data have clearly shown signatures consistent with the nonstationary character of the terrestrial bow shock. In particular, for the quasi-perpendicular part this is a very important issue of a high Mach number shock. Among several mechanisms proposed from theoretical studies and simulations to account for it, the so-called self-reformation has been intensively analyzed with simulations. One key signature of this process is that the ramp width can reach a very narrow value covering a few electron inertial lengths only and moreover is variable in time which has been confirmed from a statistical analysis from Cluster of the shock sub-structures, including also the ion foot and the overshoot, versus different plasma conditions and shock regimes. The influence of the shock nonstationarity on the particle reflection and acceleration has also been investigated to explain the properties of some previously non reported ion foreshock velocity distributions. Moreover, whistler waves associated either to dispersion at the shock front or to local micro-instabilities in the ion foot can also be present in the supercritical regime. The properties of such whistler wave packets observed both upstream of the front or in the overshoot have been presented from a multi-spacecraft analysis and discussed in the light of previous theoretical works and numerical simulations. Recent simulation work has also shown that large amplitude coherent whistler waves can be emitted in the foot region and dominate the whole shock front dynamics. This local microturbulence in particular that provided by the low frequency proton whistlers can also obviously influence the properties of reflected beams.

SCHEDULE OF TALKS

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Wednesday, April 17: 4:45 PM - 5:10 PM
Presenter: Dosch, Alexander

On Numerical Turbulence Generation for Test-Particle Simulations

A. Dosch, CSPAR, University of Alabama in Huntsville, USA
R.C. Tautz, Zentrum fuer Astronomie und Astrophysik, Technische Universitaet Berlin, Germany

A modified method is presented to generate artificial magnetic turbulence that is used for test-particle simulations. Such turbulent fields are obtained from the superposition of a set of wave modes with random polarizations and random directions of propagation. First, it is shown that the new method simultaneously fulfils requirements of isotropy, equal mean amplitude and variance for all field components, and vanishing divergence. Second, the number of wave modes required for a stochastic particle behavior is investigated by using a Lyapunov approach. For the special case of slab turbulence, it is shown that already for 16 wave modes the particle behavior agrees with that shown for considerably larger numbers of wave modes.

Thursday, April 18: 8:00 AM - 8:25 AM
Presenter: Giacalone, Joe

The Formation of Suprathermal Particles by Acceleration of Thermal Plasma at Shocks

Joe Giacalone
University of Arizona

We present results from self-consistent plasma simulations showing the efficient acceleration of thermal plasma at collisionless shocks leading to the formation of suprathermal tails in the particle distributions. We discuss two key findings from our simulations. The first is that the ratio of the injection energy -- the energy at which the distribution departs from a Maxwellian-like thermal distribution into a high-energy tail -- to the plasma-ram energy is remarkably independent of many shock parameters, including the average shock-normal angle. The second key result we discuss is that the total number of injected particles, which is related to the efficiency of the injection and acceleration can depend on a number of factors, most notably on the nature of the incident particle distribution. When there is significant energy density in pre-existing suprathermal particles, the efficiency of accelerating thermal plasma by the shock is much reduced compared to a case when there is little, or no energy in pre-existing suprathermal particles. We will present a physical interpretation of our results and discuss them in the context of interpreting spacecraft observations.

SCHEDULE OF TALKS

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Thursday, April 18: 8:25 AM - 8:50 AM
Presenter: Lukin, Vyacheslav (Slava)

Magnetic Reconnection in a Weakly Ionized Plasma

Vyacheslav S. Lukin, Naval Research Laboratory, USA
James E. Leake, George Mason University, USA
Mark G. Linton, Naval Research Laboratory, USA

Magnetic reconnection in partially ionized plasmas is a ubiquitous phenomenon spanning the range from laboratory to intergalactic scales, yet it remains poorly understood and relatively little studied. Here, we will present results from self-consistent multi-fluid simulations of magnetic reconnection in a weakly ionized reacting plasma with a particular focus on the parameter regime of the solar chromosphere. The numerical model includes collisional transport, interaction and reactions between the species, optically thin radiative losses, and a generalized Ohm's law that accounts for finite ion-inertia and electron-neutral drag. We find that during the two dimensional reconnection of a Harris current sheet with an initial width larger than the neutral-ion collisional coupling scale, the current sheet thins until its width becomes less than this coupling scale, and the neutral and ion fluids decouple upstream from the reconnection site. During this process of decoupling, we observe reconnection faster than the single-fluid Sweet-Parker prediction, with recombination and plasma outflow both playing a role in determining the reconnection rate. As the current sheet thins further and elongates it becomes unstable to the secondary tearing instability, and plasmoids can be observed. The reconnection rate, outflows and plasmoids observed in this simulation provide evidence that magnetic reconnection in the chromosphere could be responsible for jet-like transient phenomena such as spicules and chromospheric jets.

Thursday, April 18: 8:50 AM - 9:15 AM
Presenter: Le Roux, Jakobus

Solar Energetic Particle Acceleration at Fast Coronal-Mass-Ejection-Driven Shocks.

Jakobus A. le Roux,
Dept. of Physics & CSPAR, University of Alabama in Huntsville, Huntsville, AL USA

Observations suggest that solar energetic particles (SEPs) can be promptly accelerated to speeds close to the speed of light (GeV energies) in ~10 minutes to 1 hour at the fast traveling shocks formed in the corona by coronal mass ejections (CMEs). Whereas the basic physics of shock acceleration is reasonably well established, the fast shock acceleration rate presents a challenge for the theory, and many details of this process as applied to SEP events are not well understood given the complex nonlinear time-dependent three-dimensional nature of the SEP traveling shock acceleration problem. A few of the many elusive details include: (i) It is not clear how exactly SEPs are injected across the threshold for diffusive shock acceleration because there are a variety of competing shock-preheating mechanisms that can enhance the efficiency of injection. (ii) It is not understood whether quasi-parallel or quasi-perpendicular CME shock obliquities are best suited for shock acceleration of SEPs to high energies because of the uncertainty of the roles of SEP self-generation of MHD waves (quasi-parallel shock obliquity), and magnetic field-line random walk, e.g., and (iii) CME-driven shocks are complex 3D bow-shaped structures that evolve with distance from the Sun, thus leading to injection and DSA of SEPs that are highly time-dependent and dependent on location on the shock. Consequently, it is difficult to predict what the slope and maximum energy of the accelerated SEP spectrum will when the shock arrives at Earth. I will discuss the feasibility of using a focused transport theory framework to address these problems. A standard focused SEP model with self-excitation of low-frequency Alfven waves will be presented with example calculations to model SEP acceleration at a fast parallel shock. However, since standard focused transport theory only applies in the limit of near isotropy in SEP phase-angle space, it is not suitable for modeling SEP shock acceleration at quasi-perpendicular shock obliquities at lower energies close to the injection speed. I will present a newly derived generalized focused transport equation that does not impose a restriction on the SEP anisotropy in phase angle space and thus are more suitable for application at quasi-perpendicular traveling shocks.

SCHEDULE OF TALKS

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Thursday, April 18: 9:15 AM - 9:40 AM
Presenter: Lembege, Bertrand

Analysis of the Ion Quasi-Perpendicular Foreshock: 2D full PIC Simulations

Bertrand LEMBEGE,LATMOS-IPSL-UVSQ-CNRS, France
Philippe SAVOINI, LPP, France
Joel STIENLET, LPP, France

Many space missions have already evidenced the foreshock region upstream of the Earth's bow shock. In order to analyse this region, a curved shock is simulated with a 2-D particle-in-cell (PIC) code. The analysis is presently restricted to the quasi-perpendicular angular range (45°, 90°), and is focussed herein only on the ion foreshock. In agreement with experimental data, present results show two distinct ion populations collimated along the interplanetary magnetic field: (i) the field-aligned beam population (hereafter ``FAB''), and (ii) the gyro-phase bunched population (hereafter ``GPB'') which differ from each other by their gyrotropic or non-gyrotropic behavior, respectively. Ion instabilities pitch-angle scattering cannot be the source of ``GPB'' (as commonly proposed in previous works), since the present simulation time is too short. Two new criteria are proposed to identify more precisely each population: the ions interaction time Dt_int with the shock front and their downstream penetration depth. These criteria show that (i) the ``FAB'' population moves back and forth between the upstream edge of the shock front and the overshoot, and is characterized by a Dt_int covering several upstream gyro-periods. (ii) In contrast, the ``GPB'' ions suffer a short interaction time (less than one upstream ion gyyroperiod). We observe that the ``FAB'' ions may have different origins although all ``GPB'' ions seem to be produced by the electrostatic field built up at the shock and are emitted in a burst-like mode rather than in continuous way.

Thursday, April 18: 9:40 AM - 10:05 AM
Presenter: Li, Gang

Spectral Hardening of Solar Flare Continuum

Gang Li, UAH, USA
Xiangliang Kong, SDWH, CHINA
Gary Zank, UAH, USA
Yao Chen, SDWH, CHINA

Spectra of observed continuum emissions in many solar flares are consistent with double power laws with a hardening at energies >~ 300 keV. At least in electron-dominated events the hardening in photon spectrum likely reflects an intrinsic hardening in the source electron spectrum. In this paper, we show that a power law spectrum of electron with a hardening at high energies can be explained by diffusive shock acceleration of electrons at a termination shock with a finite width in solar flares. We assume the shock has a tanh profile and solve the transport equation for a p-dependent diffusion coefficient. Numerical simulations show that hardening in the accelerated electron spectrum can develop naturally. For our proposed scenario to work, that high energy electrons have to resonate with the inertial range of the MHD turbulence and low energy electrons have to resonate with the dissipation range of the MHD turbulence. It is also necessary that the spectrum of the dissipation range is proportional to k to the power of -2.7. Such a dissipation range spectrum is consistent with solar wind observations.

SCHEDULE OF TALKS

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Thursday, April 18: 10:30 AM - 10:55 AM
Presenter: Medvedev, Mikhail

Asymmetric Diffusion in Turbulent Magnetized Plasmas with a Mean Field Gradient

M.V. Medvedev

We analyze particle transport in plasmas with turbulent magnetic fields in the presence of a gradient of the mean magnetic field and weak pitch-angle diffusion. We demonstrate that such transport is described by asymmetric diffusion: the generalization of the conventional diffusion process to the case of random walk with unequal probabilities. Using a Markov chain analysis of a toy 1D model, we demonstrate that the particle density distribution becomes exponential in distance, instead of linear as is the case for the standard diffusion process. Implications of our results for the transport of cosmic rays are discussed.

Thursday, April 18: 10:55 AM - 11:20 AM
Presenter: Moraal, Harm

The Csmic-Ray Inversion Problem

H. Moraal, North-West University, South Africa

Cosmic-ray transport in the heliosphere and its variations has been measured for about 60 years. Solar activity has been monitored through the sunspot number for more than 300 years. The isotope 10Be produced by cosmic rays in the atmosphere, and deposited in polar ice, offers an opportunity to monitor the cosmic-ray intensity backwards much longer. The cosmogenic nuclide community uses this 10Be record to “invert” the modulated cosmic-ray intensity to derive solar activity parameters in the distant past. In particular, much effort is spent to infer the heliospheric – and hence solar – magnetic field. This method requires knowledge of how the modulation depth depends on transport parameters in the comic-ray diffusion tensor, and their dependence, in turn, on the magnetic field and its fluctuations. In the talk it is pointed out that the uncertainties in this inversion are still large, and it should be regarded as an unsolved problem in heliospheric physics.

Thursday, April 18: 11:20 AM - 11:45 AM
Presenter: Kucharek, Harald

3D-Hybrid Simulations for the Evolution of Ion and ENA Distributions at the Termination Shock

Harald Kucharek, Space Science Center and Department of Physics, University of New Hampshire, USA
Konstantin Gamayunov, Department of Physics and Space Sciences, Florida Institute of Technology, USA
Hans-Reinhard Mueller, Department of Physics and Astronomy, Dartmouth College, USA
Nikolai V Pogorelov, Physics Department and Center for Space Plasma and Aeronomic Research, The University of Alabama in Huntsville, USA

Energetic Neutral Atoms (ENAs) are of heliospheric origin, and a product of charge exchange of interstellar neutrals with energetic ions at the Termination Shock (TS), in the heliosheath, the heliopause, or even beyond. Their energy and phase-space distribution are directly related to the distribution of the charged component (solar wind and pickup ions). The temporal evolution is a complex product of wave-particle interactions. ENA intensity observed by IBEX at Earth's orbit depends on the location of the ion distribution at the TS, as well as on the shape in phase space. For instance ring distributions, which are very efficient in the ENA production are subject of instabilities. Some of the IBEX Ribbon models require a suppressed pitch angle scattering around 90-degree pitch angle. The growth rate of these instabilities in the different regions is therefore a key to prove or disprove some of those models. Furthermore, these wave-particle interactions also mediate shock properties such as ion reflection and surface waves. Hybrid simulations, which included all kinetic processes on the ion level, are a very powerful tool to investigate wave-particle interactions, turbulence, and phase-space evolution of pickup and solar wind ions. We performed 2D and 3D multi-species hybrid simulations for an ion-ion beam instability to study the temporal evolution of ion distributions, the growth rate and the wave properties of the generated instability, and the associated ENA generation under the influence of self-generated, self-consistent waves at and downstream of the TS.

Thursday, April 18: 11:45 AM - 12:10 PM
Presenter: Washimi, Haruichi

MHD Analysis of the Solar Wind Structure from the Photosphere to the Heliosphere

H. Washimi, G. P. Zank, Q. Hu, G. M. Webb, University of Alabama in Huntsville, CSPAR, USA
A. Nakamizo, STEL, Nagoya University, Japan
T. Tanaka, Kyushu University, Japan
M. Kojima, Nagoya University, Japan

We have developed a 3D MHD simulation model for the study of the solar-wind acceleration mechanism using WSO photospheric magnetic field at each Carrington rotation cycle. Using an unstructured mesh coordinate system on spherical surface with fine spacing in radial direction, we aim to reproduce a wide range of solar-wind plasma configuration from the photosphere to 1AU. We have incorporated external source terms into the momentum and energy equations in our MHD simulation. The energy source term consists of volumetric heating source for the corona heating which probably comes from some nonlinear wave and/or turbulent phenomena which are effective over several or even more than ten solar radii in the corona. The Spitzer-type thermal conduction term is also taken into account. The momentum source term is given in a form similar to that of the heating source. Simulation results will be compared with interplanetary scintillation (IPS) observations.

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Thursday, April 18: 1:30 PM - 1:55 PM
Presenter: Raeder, Joachim

Mechanisms of Mass, Momentum, and Energy Transfer Across Earth's Magnetopause

Joachim Raeder, University of New Hampshire, USA
Kai Germaschewski, University of New Hampshire, USA
Wenhui Li, University of New Hampshire, USA
Mattew Gilson, University of New Hampshire, USA
Shiva Kavosi, University of New Hampshire, USA
Delores Knipp, Universdity of Colorado, Boulder, USA

The solar wind and interplanetary magnetic filed (IMF) are the primary drivers for the dynamics of Earth's magnetosphere. While the magnetosphere largely shields the Earth from the solar wind and the IMF, the barrier, i.e., the magnetopause undergoes various processes that allow plasma and energy to enter and to drive magnetospheric activity. Old paradigms have it that southward IMF is largely responsible for opening up the magnetosphere via reconnection. However, there is now increasing evidence that processes such as field line capture, Kelvin-Helmholtz waves, and concentrated Poynting Flux in the cusps during times of northward IMF are not only important, but sometimes dominant and more efficient to let plasma and energy enter the magnetosphere. In this talk we will present recent data from THEMIS, DMSP, and other missions, as well as global OpenGGCM simulations of the magnetosphere to investigate and understand the transport processes.

Thursday, April 18: 1:55 PM - 2:20 PM
Presenter: Parks, George

Reinterpretation of Slowdown of Solar Wind Mean Velocity in Nonlinear Structures Observed Upstream of Earth’s Bow shock

G. K. Parks, UC Berkeley, Berkeley, CA
E. S. Lee, Kyung Hee University, Yongin, Korea
N. Lin, UC Berkeley, Berkeley, CA
S. Y. Fu, Peking University, Beijing, China
J. B. Cao, Beihang University, Beijing, China
J. Hong, Physics, KEIST, Korea
Y. Liu, NSSC, Academy of Sciences, Beijing
M. Goldstein, NASA GSFC, Greenbelt, MD
P. Canu, Ecole Polytechnique, Paris, France
I. Dandouras, CNRS, IRAP, Toulouse, France
H. Rème, CNRS, IRAP, Toulouse, France

Density holes (DH), Hot Flow Anomalies (HFA) and Short Large Amplitude Magnetic Structures (SLAMS) are transient nonlinear structures observed in the upstream region of Earth’s bow shock. One outstanding problem concerns the relationship of the nonlinear structures and the bow shock. Another is what can cause the velocity of the solar wind to slow down and be diverted within these structures. In 2010 and 2011, Cluster plasma ion experiment was configured to sample 3D distributions of the SW and the back streaming particles with spin period time resolution (4s). The new data show the SW beam in the upstream structures is persistent and the slowdown of the SW flow is due to reflected particles canceling the SW beam in the calculation of the velocity moment. We present new observations including examples of how the upstream nonlinear structures could evolve into shocks.

SCHEDULE OF TALKS

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Thursday, April 18: 2:20 PM - 2:45 PM
Presenter: Oka, Mitsuo

Non-thermal Electrons in Solar Flares and the Earth's Magnetotail

Mitsuo Oka, UC Berkeley, USA
Tai Phan, UC Berkeley, USA
Sa"m Krucker, UC Berkeley, USA, i4Ds, University of Applied Sciences and Arts Northwestern Switzerland, Switzerland

Explosive phenomena in the solar corona and the Earth's magnetotail produce non-thermal, energetic electrons of up to tens of MeV and hundreds of keV, respectively. While previous theories have considered shock, reconnection and turbulence as the key process for producing energetic electrons, the precise mechanism remains unclear. Here we propose to compare the power-law spectral indices obtained by hard X-ray observations during solar flares as well as in-situ electron measurements in the Earth's magnetotail. We will present a solar flare case study in which the kappa distribution was applied in addition to the conventional power-law model with a low-energy cutoff. We will also present another case study from the Earth's magnetotail in which multiple THEMIS spacecraft measured energetic electrons simultaneously in both the reconnection (inner-) diffusion region and the reconnection flow-braking region.

Thursday, April 18: 2:45 PM - 3:10 PM
Presenter: Verkhoglyadova, Olga

Middle Atmosphere Response to Large SEP Events

O.P. Verkhoglyadova, CSPAR/UAH, JPL/Caltech, USA
S. Wang, JPL/Caltech, USA

Solar proton events (SPEs) have been shown to affect chemical balance of the middle atmosphere (from 60 to 90 km in altitude). Solar protons of energies above 10 MeV penetrate deep into the atmosphere temporarily inducing production of chemically active odd hydrogen species (HOx, primarily OH and HO2) which in turn causes ozone (O3) destruction. Latitudinal extend of HOx signature is dependent on geomagnetic cut-off latitude and changes due to geomagnetic conditions, especially during geomagnetic storms. The Microwave Limb Sounder (MLS) launched on board Aura satellite in 2004 provides daily simultaneous measurements of HOx, O3 and related parameters such as H2O and temperature on a global scale during both day and night. This is the first time that global measurements of odd hydrogen species are made on a daily basis. First, we briefly review latest observational and modeling results on odd hydrogen density increases during SPEs. Then, we will present analysis of 3 large solar energetic particle (SEP) events (starting around 15 Jan. 2005, 6 Sept. 2005 and 5 Dec. 2006) and corresponding middle atmospheric signatures. We will use GOES Environment Monitor data to describe evolution of energetic proton fluxes near the Earth. We will discuss impulsive SEPs (of a flare origin) and gradual SEPs (accelerated at a CME-driven shock) as sources of energetic protons. Measurements from MLS will be utilized to study nighttime odd hydrogen density dynamics throughout the events.We will demonstrate how interplanetary shocks and related accelerated particles affect the mesosphere and upper stratosphere.

SCHEDULE OF TALKS

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Thursday, April 18: 3:30 PM - 3:55 PM
Presenter: Hill, Matthew

Anomalous and Galactic Cosmic Rays Near the Heliocliff

M.E. Hill [1], R.B. Decker [1], D.C. Hamilton [2], T.P. Armstrong [3], L.E. Brown [1], G. Gloeckler [4], S.M. Krimigis [1], L.J. Lanzerotti [5], and E.C. Roelof [1]
[1] Johns Hopkins University Applied Physics Laboratory, USA
[2] University of Maryland, USA
[3] Fundamental Technologies, USA
[4] University of Michigan, USA
[5] New Jersey Institute of Technology, USA

On August 25, 2012 Voyager 1 crossed a major and totally unexpected boundary, dubbed the “heliocliff”, beyond which energetic particles of solar origin all but vanished (intensities decreased by roughly three orders of magnitude), while the galactic cosmic ray (GCR) intensities and the magnetic field strength increased markedly. Anomalous cosmic ray (ACR) intensities also decreased significantly at the heliocliff, but generally not as abruptly as for the lower energy particles. About a month before the August 25 crossing there were precursors events and over two months before this, on May 8, GCRs exhibited a unusual and unexplained increase, which was the first indication of the subsequent drama. The intensities of GCRs beyond the heliocliff, in the “depletion region”, vary significantly with time suggesting that the unperturbed interstellar spectrum in not yet being observed (as rapid temporal or spatial variations would be unexpected in that large-scale regime). We report energetic particle measurements from the Voyager 1 Low Energy Charged Particle instrument during this remarkable period, concentrating on anomalous and galactic cosmic rays.

Thursday, April 18: 3:55 PM - 4:20 PM
Presenter: Ratkiewicz, Romana

Interstellar Magnetic Field in the Nearest Surroundings of the Sun

Romana Ratkiewicz, Institute of Aviation and Space Research Center PAS, Warsaw, Poland
Marek Strumik, Space Research Center PAS, Warsaw, Poland
Jolanta Grygorczuk, Space Research Center PAS, Warsaw, Poland
Lotfi Ben-Jaffel, UPMC, CNRS, IAP, Paris, France

A large number of results of MHD models of the interaction between the solar wind (SW) and the local interstellar medium (LISM) is available nowadays. A central assumption in these studies is that the unperturbed interstellar magnetic field (ISMF), which is unknown, has a constant intensity and direction. Therefore the main purpose of the investigations made by several groups of researchers is to find the specific ISMF parameters. In modeling the interaction of the SW with the LISM, the boundary conditions play an important role. The state of the LISM near the Sun and the behavior of the
solar wind determine the shape and structure of the heliosphere. Results of theoretical modeling of the heliosphere are verified against in situ measurements and remote observations of the heliosphere. However, up to now most comparison efforts do not agree on a unique solution for the ISMF strength and orientation. We discuss possible reasons of the ambiguity by outlining differences and similarities of MHD models published up to now.

SCHEDULE OF TALKS

NOTES

Thursday, April 18: 4:20 PM - 4:45 PM
Presenter: Borovikov, Sergey

Investigating the Heliotail Structure with a MHD-kinetic Model

Sergey Borovikov, Jacob Heerikhuisen, and Nikolai Pogorelov

The heliotail structure is of interest for the analyses of the Lyman-alpha absorption in the direction of the nearby starts and the energetic neutrals (ENA) production. Recent Interstellar Boundary Explorer (IBEX) observations revealed rather complex topologu of the heliotail (McComas etal. 2013). In our presentation we use 3D, MHD-kinetic modeling to analyze the heliotail region up to 5000 AU, downstream. We examine the role of the interstellar magnetic field in shaping the heliopause. The heliospheric current sheet behavior and the heliopause instability is analyzed. We found out the heliopause is noticeably squeezed and appears no well defined boundary between the solar wind and the local interstellar medium in at distances greater than 1500 AU.

Thursday, April 18: 4:45 PM - 5:10 PM
Presenter: Roelof, Edmond

The IBEX “Ribbon” Produced as a Consequence of Global Plasma Flow Patterns in the Heliosheath

Edmond C. Roelof, Johns Hopkins U./Applied Physics Lab., USA

Beginning almost immediately with the discovery of the “ribbon” in the first complete IBEX map of the ENA sky in 2009, a series of papers (right up to the present) have offered explanations for this strikingly narrow (27 deg FWHM) feature in terms of a region of enhanced energetic proton intensities (1-4 keV) at radial distances beyond the heliopause. Not specifically addressed in any detail is the origin of the ENA intensity “distributed” [Schwadron et al., Astrophys. J., 2011] over the vast remainder of the sky that is down only a factor of 3 or less from the peak of the ribbon. We have recently suggested [Roelof, AGU, 2012] that the Compton-Getting effect due to the global spatial variation of the radial component of the heliosheath plasma flow can result in a comparable enhancement in the observed 1-4 keV ENA intensities (even if the proton intensity is relatively uniform throughout the heliosheath). This result follows quantitatively from the simple assumption that the “ribbon” actually overlies a region of relatively stagnated radial outflow, whereas the “distributed” ENA intensity in the rest of the sky emanates from relatively free radial outflow. The effect is a consequence of the negative slope of the heliosheath proton spectrum; ENAs traveling radially inward with velocity (v) will be generated by protons having velocity v’=v+V with respect to the outward-moving plasma (flow velocity V). An immediate (an unavoidable) implication is that the ENA ribbon FWHM will be nearly independent of ENA energy in the range where it is brightest. The shape and the location of the observed ENA ribbon (a cone with 72deg opening angle) dictates the shape and location of the reduction in the radial plasma outflow, i.e., approximately transverse to the presumed direction of the distant interstellar magnetic field. The “distributed” ENA intensity is then that of the free outflow (non-stagnated) regions. Remarkably, the mathematical description has only a single remaining free parameter: the difference in radial plasma velocity between the outflow in the “distributed” region and the reduced outflow in the stagnated “ribbon” region. A line-of-sight-averaged peak radial flow velocity difference of 90 km/s suffices to reproduce the spectral properties of the IBEX ribbon enhancement with this single free parameter. Even if this model is over-simplified, it nonetheless establishes that the Compton-Getting effect is encoding valuable information on the global patterns of the heliosheath plasma flow into the IBEX ENA skymaps.

Thursday, April 18: 5:10 PM - 5:35 PM
Presenter: Kota, Jozsef

Galactic and Anomalous Cosmic Rays around the Heliopause

Jozsef Kota, University of Arizona, USA
J.R. Jokipii, University of Arizona, USA

We discuss the spatial distribution of galactic and anomalous cosmic rays (ACRs and GCRs) at and beyond the heliopause (HP). First we study the possible modulation of GCRs beyond the HP using a simplified spherical model similar to that used by Scherer et al. (2011) and arrive at different conclusion. Combining numerical and analytical calculations we find that the modulation of GCRs should likely remain quite small. Next we consider a non-spherical but still largely simplified HP to examine the role of parallel and perpendicular diffusion beyond the HP. We find that the fast parallel diffusion reduces the modulation beyond the HP even if the perpendicular diffusion is moderate. We also address the role magnetic connection may play near the HP. We employ our code of focused transport adding ad-hoc cross field diffusion. We shall present preliminary results and discuss their implications.

Thursday, April 18: 5:35 PM - 6:00 PM
Presenter: Frisch, Priscilla

Small-scale Interstellar Structure and the Heliosphere

Priscilla C. Frisch, University of Chicago, USA

The turbulent magnetized interstellar plasma interacts with the heliosphere in the outer heliosheath region beyond the heliopause. Variations in the neutral and ionized interstellar medium appear over all spatial scales. As the Sun travels through the local interstellar medium at 23 km/s, small-scale structure in the interstellar medium could affect observations of interstellar gas inside of the heliosphere and in heliosheath regions. The consequences of these interactions on the observables of the outer heliosheath are unknown. This talk will explore whether the interactions between small scale structure in the local ISM and the evolving heliosphere might affect our measurements of the outer heliosheath and inside of the heliosphere.

Friday, April 19: 8:00 AM - 8:25 AM
Presenter: Ho, George

3He Enhanced Solar Energetic Particle Events in Cycle 24

George C. Ho and Glenn M. Mason

We investigated 3He-rich solar energetic particle (SEP) events in the current solar cycle starting in 2009 through the current date. Both 3He-rich and CME-related events are included. Simultaneous measurements from the ULEIS instrument on ACE, and SIT instruments on STEREO spacecraft are used to determine the spatial properties and origin of 3He-rich events. During the last solar cycle, we found an unexpected upper limit of the 3He fluence, while none is observed for 4He. The unexpected fluence distributions provide important constraints on possible acceleration processes. One of the interpretations is that only limited number of energetic 3He ions can be released from the Sun in a SEP event since the 3He originates in compact regions. Thus, the upper limit on the 3He fluence that we observed may be giving us information on the maximum size of the 3He acceleration region. In this paper, we will review the 3He observations so far in this solar cycle and examine the measurement requirement of this important isotope.

Friday, April 19: 8:25 AM - 8:50 AM
Presenter: Wu, S. T.

Analyses of the Evolution and Interaction of Multiple Coronal Mass Ejections and Their Shocks in July 2012

S. T. Wu, The University of Alabama in Huntsville, USA
Chin-Chun Wu Naval Research Laboratory, USA
Kan Liou, Applied Physics Laboratory, USA
Simon Plunkett, Naval Research Laboratory, USA
Murray Dryer, NOAA Space Prediction Center (Ret), USA
C. D. Fry, Exploration Physics International, USA

The Sun has been getting more active since 2010, after a long-lasting solar minimum (2007-2009). Many Coronal Mass Ejections (CMEs) have been detected by the current orbiting instruments (SOHO/LASCO, STEREO-A and B). During the period July 2012, three consecutive CMEs were observed on July 17 (~13:54UT), July 18 (~06:24UT), and July 19 (~05:39UT) from different source regions on the solar surface located at S23W61, N18W180, and S17W92, with speeds of 802, 713 and 1160 km/s respectively. Multiple interplanetary (IP) shocks and CMEs arrived at the twin STEREO-A/B, SOHO/LASCO, ACE and WIND spacecrafts where the STEREO-A and -B were orbiting near 121 degrees west and 114 degrees east of the Sun-Earth line. The orbit of ACE and SOHO/LASCO were at L1 and WIND was near the Sun-Earth line. This line-up gives us an opportunity to understand the correspondence between observed CMEs and IP shocks employing a global three-dimensional simulation model (Wu et al. 2007) to perform a forward MHD modeling to investigate the evolution of these CMEs and IP shocks and the interaction between them. Using the simulation results together with observation, we found that an IP shock driven by the July 18 CME arrived at STEREO-B first, another IP shock driven by the July 19 CME arrived at STEREO-A, and then the flank of a shock driven by the July 17th CME arrived at Earth. The observations from coronal images and in-situ solar wind data and simulation will be discussed in detail.

Friday, April 19: 8:50 AM - 9:15 AM
Presenter: Hu, Qiang

Characteristics of Magnetic Flux Ropes from the Sun to the Heliosphere

Qiang Hu, Department of Physics/CSPAR, UAHuntsville, Huntsville, AL 35805, USA
Jiong Qiu, Physics Department, Montana State University, Bozeman, MT 59717-3840, USA

The magnetic flux-rope structures are observed on the Sun and in the heliosphere. In particular, the in-situ measurements in interplanetary space provide definitive evidence of existence of such structures, often embedded within large-scale Interplanetary Coronal Mass Ejections (ICMEs). Such in-situ measurements enable quantitative modeling of these structures and effort has been made to establish the physical connection with their solar sources. We will apply the Grad-Shafranov reconstruction technique to examine the configuration of interplanetary flux ropes and to derive relevant geometrical and physical quantities, such as magnetic flux content, the field-line twist, and relative magnetic helicity. We will select recent events during the rising phase of enhanced solar activity, and utilize additional observations from the most recent spacecraft missions, such as the STEREO and SDO spacecraft. Both observational analyses of solar source region characteristics including flaring and dimming, and the corresponding flux-rope structures will be presented. A recent development in taking into account the torus-shaped flux-rope geometry will be discussed. We show in detail the variations of the relevant quantities along different cylindrical shells around the central axis that characterize such flux-rope configuration.

SCHEDULE OF TALKS

NOTES

Friday, April 19: 9:15 AM - 9:40 AM
Presenter: Jokipii, J. R. (Randy)

Fast-Charged-Particle Acceleration at Collisionless Plasma Compressions and Shear

J. R. Jokipii
Jozsef Kota

The acceleration of fast charged particles by fluid compressions and shear has been discussed by a number of authors. These mechanisms depend on the spatial derivatives of the velocity field and accelerate particles more rapidly for larger derivatives. Since naturally occurring fluctuations generally have Kolgmogorov-like spatial power spectra, the smaller scales dominate the spectra of derivatives. We will present an analysis of the mechanisms for Kolmogorov pwoer spectra.

Friday, April 19: 9:40 AM - 10:05 AM
Presenter: Kim, Tae

Modeling the Global Heliosphere Using IPS-derived Time-dependent Boundary Conditions

Tae K. Kim, Center for Space Plasma and Aeronomic Research, The University of Alabama in Huntsville, U.S.A.
Nikolai V. Pogorelov, Center for Space Plasma and Aeronomic Research, The University of Alabama in Huntsville, U.S.A.
Sergey N. Borovikov, Center for Space Plasma and Aeronomic Research, The University of Alabama in Huntsville, U.S.A.
Keiji Hayashi, W. W. Hansen Experimental Physics Lab., Stanford University, U.S.A.
Bernard V. Jackson, Center for Astrophysics and Space Sciences, University of California, San Diego, U.S.A.
Munetoshi Tokumaru, Solar-Terrestrial Environment Laboratory, Nagoya University, Japan
Hsiu-Shan Yu, Center for Astrophysics and Space Sciences, University of California, San Diego, U.S.A.

Interplanetary scintillation (IPS) observations are a well-known, powerful tool that have long been used in solar wind (SW) forecasting. In the last couple of decades, several tomography methods have been developed to reconstruct the time-varying 3D SW structure from IPS observations with reasonably good accuracy out to several astronomical units beyond Earth's orbit. With some of these tomographic reconstructions at certain fixed heliocentric distances as time-dependent boundary conditions, we have simulated the plasma flow in the inner heliosphere magnetohydrodynamically (MHD) and in the outer heliosphere using an MHD-neutral model. Since the SW structure often changes significantly in time, the accuracy of the boundary conditions are particularly important in modeling the SW outflow in interplanetary space and the interaction between the SW and the local interstellar medium at the edge of the heliosphere. In this talk, we summarize our past and current efforts in modeling the global heliosphere using IPS-based time-varying boundary conditions and discuss how we may improve the accuracy of our SW reconstructions.

SCHEDULE OF TALKS

NOTES

Friday, April 19: 10:30 AM - 10:55 AM
Presenter: Golla, Thejappa

Non-linear Processes in Solar Type III Radio Bursts

G. Thejappa, University of Maryland College Park MD USA
R. J. MacDowall, NASA/GSFC, Greenbelt MD USA
M. Bergamo, University of Maryland, College Park MD USA

One of the outstanding problems in solar radio astronomy is the identification of the non-linear processes responsible for the stabilization of solar type III radio burst associated electron beams so that they can travel distances of the order of 1 AU and more without losing much of their energy, and conversion of Langmuir waves into electromagnetic waves at the second harmonic of the electron plasma frequency. We address this issue using the high time resolution in situ observations obtained by the WAVES experiment of the STEREO spacecraft, which show that in solar type III bursts, Langmuir waves often occur as intense localized wave packets with durations of only a few ms. We present a detailed analysis of these wave packets, and show that (1) the peak intensities are well above the threshold for the oscillating two stream instability (OTSI) and supersonic collapse, (2) the peak intensities and spatial scales satisfy the criterion for them to be collapsing envelope solitons, (3) the low frequency components provide evidence for density cavities, whose depths, widths and temporal coincidences indicate that probably they are self-generated by the ponderomotive forces, and (4) the spectra of these wave packets contain primary peaks at the local electron plasma frequency, two sidebands, and low frequency enhancements below a few hundred Hz, corresponding to the beam-excited Langmuir waves, down- and up-shifted daughter Langmuir waves, and daughter ion sound waves, respectively, with frequencies, wave numbers and phases satisfying the resonance conditions of the four wave interaction OTSI, and (5) the spectra also contain peaks at twice the electron plasma frequency, which as shown by the bispectral analysis correspond to the electromagnetic waves generated as a result of coalescence of oppositely propagating up- and down-shifted Langmuir waves, excited by OTSI. Thus, we for the first time provide combined evidence that (1) the OTSI and related strong turbulence processes probably are responsible for the stabilization of the electron beam, (2) the coalescence of the oppositely propagating up- and down-shifted daughter Langmuir waves excited by the OTSI is probably the emission mechanism of the second harmonic radiation, and (3) the Langmuir collapse follows the route of OTSI in type III radio bursts.

Friday, April 19: 10:55 AM - 11:20 AM
Presenter: Lee, Martin

Fluence Energy Spectra of Ground Level Events

Martin Lee

N/A

Friday, April 19: 11:20 AM - 11:45 AM
Presenter: Adams, Jim

Probabilistic Model for Solar Energetic Particle Events

J.H. Adams, Jr., Z.D. Robinson, C. Stauffer and M.A. Xapsos

Solar energetic particle events so dominate the space radiation environment, they must be considered in both the design and the planning of crewed space missions and crew activities during these missions. For this reason, a design reference environment is needed both for entire missions and for specific crew activities, especially EVAs. This paper will describe a method for determining a reference environment which represents an upper bound on possible solar particle events during any specified period at a specified confidence level.

POSTER PRESENTATIONS

Fujiki, Ken'ichi	**MHD Analysis of the Velocity Oscillations in the Outer Heliosphere Using Interplanetary Scintillation Data** Authors: Ken'ichi Fujiki, STEL, Nagoya University, Japan Haruichi Washimi, CSPAR, University of Alabama, USA Keiji Hayashi, HEPL, Stanford University, USA Gary P. Zank, CSPAR, University of Alabama, USA Munetoshi Tokumaru, STEL, Nagoya University, Japan Takashi Tanaka, Faculty of Science, Kyushu University, Japan Vladimir Florinski, CSPAR, University of Alabama, USA Yuki Kubo, NICT, Japan A realistic three-dimensional MHD simulation by using interplanetary scintillation observation data as inner boundary with fine mesh is performed from the year of 2001 to 2009. Three-dimensional solar wind structure is reconstructed from 5 AU to the outer heliosphere. We found that a wavy solar wind velocity structure fills interplanetary space beyond 40–60 AU. The wavy structure is a monochromatic velocity oscillation with wavelength of 2 AU and amplitudes of 10–50 km/s. These properties are essentially the same as the velocity oscillation found by Voyager 2 PLS instruments (Paularena et al. 1996) except for two times larger wavelength. The dispersion relation derived by Zank et al. (2005) indicates that the oscillation propagates inwardly in the solar wind frame. Also we found by three-dimensional analyses that the oscillation is generated as a local spherical wave with a center at the Sun and carried outward by background solar wind. References 1. M. Kojima, M. Tokumaru, H. Watanabe, A. Yokobe, K. Asai, B. V. Jackson, P. L. Hick, JGR, Vol.103, Issue A2, pp. 1981-1990 2. K. Hayashi, H. Washimi, and M. Tokumaru, AIP Conf. Proc. 1436,308 (2012). 3. H. Washimi, K. Hayashi, M. Tokumaru, G.P. Zank, Q. Hu, T. Tanaka, V. Florinski, J. Adams, and Y. Kubo, AIA Conf. Proc. 1436, 350 (2012). 4. K.I. Paularena, J.W. belcher, J.D. Richardson, G.S. Gordon Jr, and A.J. Lazarus, GRL, 23, 1685 (1996). 5. G.P. Zank, X. Ao, and J.D. Richardson, JGR, 110, A05103 (2005).
Song, Paul	**Alfven Waves in the Chromosphere: Propagation, Reflection, and Absorption** Authors: Jiannan Tu and Paul Song Center for Atmospheric Research and Physics Department, University of Massachusetts Lowell, USA The propagation, reflection and absorption of Alfven waves from the photosphere is studied by numerically solving a self-consistent one-dimensional model of the chromosphere with strong electron-neutral and ion-neutral collisions included. The governing equations, being very stiff because of the strong coupling between the charged and neutral fluids, are solved with an implicit backward difference formula (BDF2) of second order accuracy both in time and space. The simulation results show that the Alfven waves at frequencies higher than certain critical frequency, depending on the strength of the background magnetic field, are strongly damped, which is consistent with the recent theoretical analysis by Song and Vasyliunas [J. Geophys. Res., 116, A09104, doi:10.1029/2011JA016679, 2011]. The simulation results also reveal some features that are not present in the study of Song and Vasyliunas due to simplifying assumptions in their work.

POSTER PRESENTATIONS

Webb, Gary	**Advected Invariants in Magnetohydrodynamics and Gas Dynamics** Authors: G. M. Webb, CSPAR, The University of Alabama in Huntsville, Huntsville AL 35805, Q. Hu, Department of Physics, The University of Alabama in Huntsville, Huntsville AL 35899, and CSPAR, The University of Alabama in Huntsville, Huntsville AL 35805, J. F. McKenzie,CSPAR, The University of Alabama in Huntsville, Huntsville AL 35805, Department of Mathematics and Statistics, Durban University of Technology, Durban RSA, 4041, and School of Mathematical Sciences, University of Kwa-Zulu Natal, Durban Republic of South Africa B. Dasgupta, CSPAR, The University of Alabama in Huntsville, Huntsville AL 35805, G. P. Zank, Department of Physics, The University of Alabama in Huntsville, Huntsville AL 35899 and CSPAR, The University of Alabama in Huntsville, Huntsville AL 35805, In this paper we discuss conservation laws in ideal magnetohydrodynamics (MHD) and gas dynamics associated with advected invariants. The invariants in some cases, can be related to fluid relabeling symmetries associated with the Lagrangian map. There are different classes of invariants that are advected or Lie dragged with the flow. Simple examples are the advection of the entropy S (a 0-form), and the conservation of magnetic flux (an invariant 2-form advected with the flow). The conservation of magnetic flux conservation law is equivalent to Faraday's equation. We discuss the gauge condition required for the magnetic helicity to be advected with the flow. The conditions for the cross helicity to be an invariant are discussed. We discuss the different variants of helicity in fluid dynamics and in MHD, including: fluid kinetic helicity, cross helicity, magnetic helicity, Ertel's theorem and potential helicity, the Hollman invariant, and the Godbillon Vey invariant for special flows for which the magnetic helicity is zero.

12th Annual International Astrophysics Conference
Sheraton Myrtle Beach Convention Center Hotel
Myrtle Beach, SC, April 15 – 19, 2013

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