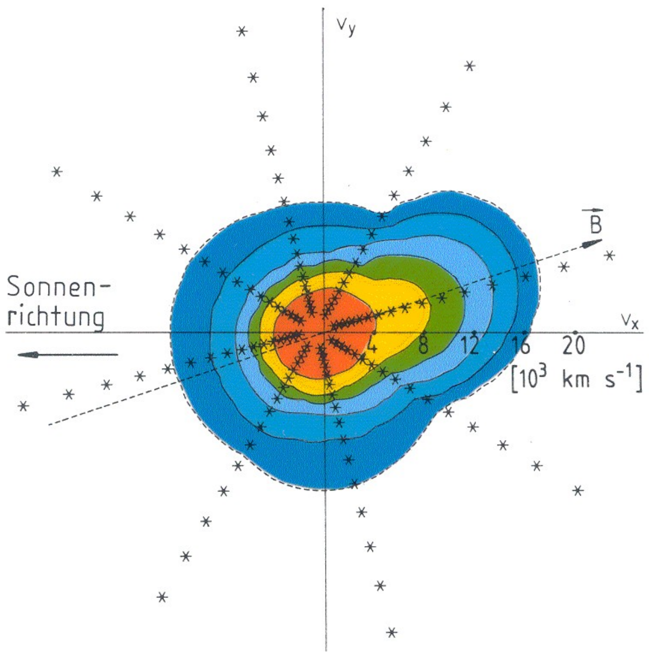
511TH WE-Heraeus-Seminar

From the Heliosphere into the Sun

– Sailing against the Wind –

Programme book incuding all abstracts



Physikzentrum Bad Honnef, Germany

January 31 – February 3, 2012

http://www.mps.mpg.de/meetings/heliocorona/

MAX-PLANCK-GESELLSCHAFT

MPS

Wilhelm und Else Heraeus Stiftung

From the Heliosphere into the Sun

A meeting dedicated to the progress of our understanding
of the solar wind and the corona
in the light of the upcoming Solar Orbiter mission

This meeting is dedicated to the processes in the solar wind and corona in the light of the upcoming Solar Orbiter mission. Over the last three decades there has been astonishing progress in our understanding of the solar corona and the inner heliosphere driven by remote-sensing and in-situ observations. This period of time has seen the first high-resolution X-ray and EUV observations of the corona and the first detailed measurements of the ion and electron velocity distribution functions in the inner heliosphere. Today we know that we have to treat the corona and the wind as one single object, which calls for a mission that is fully designed to investigate the interwoven processes all the way from the solar surface to the heliosphere.

The meeting will provide a forum to review the advances over the last decades, relate them to our current understanding and to discuss future directions. We will concentrate one day on in-situ observations and related models of the inner heliosphere, and spend another day on remote sensing observations and modeling of the corona – always with an eye on the symbiotic nature of the two. On the third day we will direct our view towards the future.

This meeting is timely because we have, on 4 October 2011, experienced the final selection and approval of the Solar Orbiter mission for a launch in 2017. Last but not least we will take the opportunity of this meeting to celebrate the career of Eckart Marsch, who was one of the major drivers of Solar Orbiter and its predecessors for the better part of his career.

The meeting is held in the Physikzentrum Bad Honnef near Bonn, Germany. This is is a conference center of the German Physical Society (DPG), the largest physical society in the world, and is organized by the Max Planck Institute for Solar System Research (MPS).

This seminar is generously funded by the Wilhelm and Else Heraeus Foundation.

Meeting Venue

The meeting will be held in the Physikzentrum Bad Honnef near Bonn, Germany. This is is a conference center of the German Physical Society, the largest physical society in the world. The Physikzentrum is known for its stimulating atmosphere for meetings with between 50 and 100 participants. You can get an impression of the atmosphere by checking these photographs on the web page of the Physikzentrum.

The Bonn area can be reached by train, plane, car, or even by boat if you are coming along the Rhine river. Being the former capital of Germany, Bonn is a lively university town with a broad range of cultural activities. The Physikzentrum can be easily reached via tram from the main station in Bonn or the Köln-Bonn airport in about 1/2 hour.

The address of the venue is: Physikzentrum Bad Honnef
Hauptstrafle 5
D-53604 Bad Honnef
Germany

Organizers

Hardi Peter, Eckart Marsch, Jörg Büchner
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Guidelines for Presentations

Posters

The poster boards have a size of 120 cm (horizontally) by 150 cm (vertically). This corresponds to 47 by 59 inch. So an A0 format poster would fit in portrait as well as in landscape mode on the board.

All posters will be up during the whole meeting. You can put up your posters starting from Tuesday afternoon/evening. Please put your poster up on the board showing your poster number and abstract. You can find your poster number in the programme (left column on page 6) or with the abstracts starting on page 22.

There are two dedicated poster sessions followed by a coffee break:
→ Wednesday, 15:10-16:10 and
→ Thursday, 15:30-16:10.

Talks

For the talks we suggest that you use the computer installed at the lecture hall, if possible. This runs the most recent Windows operating system with up-to date versions of programs to display PowerPoint and PDF files.

Using the lecture hall computer has the major advantage that we do not loose time for connecting the laptops and solving display problems, should they occur. If you have complicated movies included in your presentation, it might be preferable if you use your own laptop. Mac users who prepared their talk in PowerPoint might also use the computer in the lecture hall. If you use Keynote, please use your own laptop.

Please make sure to deliver and test your talk at the lecture hall computer at least during the break before the session before your own session! Only this can assure that a problem that might occur can be solved. If you use your own laptop, ensure to test that everything works fine at least during the break before the session before your own session! Speakers of the first session (Wednesday before lunch) are asked to check on Tuesday evening, if possible.

All contributed talks are 15 minutes plus 5 minutes of discussion time. Because we hope to have lively discussions, please make an effort to stay within the 15 minutes. The chairmen will keep an eye on the timing... For the invited talks the same guideline applies, only that invited speakers should leave a bit more time (about 10 minutes) for discussions.

Social Events

General

We will have joined breakfast, lunch and dinner for all participants in the Physikzentrum. Please note that lunches will start sharp at 12:45 and dinners at 18:30. In the evenings (after dinner), the Physikzentrum is famous for its nice inspiring atmosphere, where we can have lengthy discussions and some drinks. These drinks are available at cost price.

Welcome evening, Tuesday, 31 Jan

We will have a welcome evening the night before the science part of the meeting starts. Some light snacks will be served ("cold buffet").

We will start at around 18:00, open end. This event will take place in the Physikzentrum, i.e. the conference venue.

Heraeus evening / conference dinner, Wednesday, 1 Feb

The Heraeus Foundation generously sponsors an evening with a nice dinner and drinks. This evening will also be a good opportunity to have some celebration of the career of Eckart Marsch.

The conference dinner will start at 18:30 in the Physikzentrum.

Free evening, Thursday, 2 Feb

After dinner on Thursday evening, there will be time to either explore some pubs in the vicinity of the Physikzentrum (we will provide some suggestions), or to stay on in the Physikzentrum and have a drink.

Friday afternoon, 3. Feb

The meeting will end on Friday after we had a common lunch. Some people might have to stay until Saturday, because they do not get a connection back home. For those we will provide some information on what to do on Friday afternoon, and you could form small or large groups to explore Bad Honnef and/or Bonn. Especially Bonn is well know for its museums (e.g., the Bundeskunsthalle which is the national exhibition hall of Germany).

invited talk
contributed

Schedule "From the Heliosphere into the Sun" 31. Jan - 3 Feb 2011

	Tue 31. Jan	**Welcome evening**		
	start @ 18:00	*some light snacks and drinks*		

	Wed 1. Feb	**In-situ science**		
	09:20 - 10:00	R. Wimmer	Schweingruber	From Helios to the outer heliosphere - observational frontiers
	10:00 - 10:20	Tim	Howard	Imaging the Solar Wind in the Corona and Heliosphere
	10:20 - 10:40	Matthias	Hahn	Coronal Mass Ejections detected during radio sounding observations with the MEX
Coffee				
	11:10 - 11:50	Stefano	Livi	Heavy ions in the solar wind
	11:50 - 12:10	Sofiane	Bourouaine	Ion Heating and Turbulence Dissipation in Solar Wind
	12:10 - 12:30	Daniel	Verscharen	The anisotropic cascade of solar wind turbulence beyond MHD scales
Lunch	12:45			
	14:30 - 15:10	Chuanyi	Tu	Origin and Acceleration of Fast Solar Wind
POSTER	15:10 - 16:10			
Coffee				
	16:40 - 17:20	Roberto	Bruno	In-situ observations on anisotropic turbulence
	17:20 - 17:40	Andrea	Verdini	On the origin of the 1/f spectrum in the solar wind
	17:40 - 18:00	Tien (Tom)	Chang	ROMA (Rank-Ordered Multifractal Analysis) of Intermittency in Space Plasmas
Dinner	18:30 - open	*Conference dinner / Heraeus evening*		

	Thu, 2. Feb	**Coronal Science**		
	09:00 - 09:40	Steven R.	Cranmer	Connecting the Solar Wind to the Corona
	09:40 - 10:00	Klaus	Wilhelm	Morphology, dynamics and plasma parameters of plumes and inter-plume regions
	10:00 - 10:20	Leon	Ofman	2D Hybrid Models of Expanding Solar Wind H^{+}-He^{++} Plasma Heating
	10:20 - 10:40	Håkan M.	Smith	Electron transport in the fast solar wind
Coffee				
	11:10 - 11:50	Gottfried	Mann	Particle Acceleration and Plasma Kinetics in the Corona and Wind
	11:50 - 12:10	Jingnan	Guo	Energy-dependent electron distributions in flare loops
	12:10 - 12:30	Christian	Vocks	Suprathermal electron production in the quiet solar corona
Lunch	12:45			
	14:30 - 15:10	Hui	Tian	Crossing the transition region
	15:10 - 15:30	Lidong	Xia	Coronal holes observed by SUMER/SOHO, EIS/Hinode and AIA/SDO
POSTER	15:30 - 16:10			
Coffee				
	16:40 - 17:00	Miroslav	Barta	Processes of turbulent cascade in large-scale magnetic reconnection
	17:00 - 17:20	Takuma	Matsumoto	From the photosphere to the solar wind: 2D MHD simulation of Alfven wave
	17:20 - 18:00	Eric	Priest	Where to go beyond MHD?
Dinner	18:30 - 20:00			
Free evening		*Enjoy some local pubs in Bad Honnef or just stay on in the Physikzentrum for a beer...*		

	Fri, 3. Feb	**Where to go from here...**		
	09:00 - 09:30	Richard G.	Marsden	Future science with Solar Orbiter
	09:30 - 09:50	Sami	Solanki	PHI on SolarOrbiter
	09:50 - 10:10	Laurel A.	Rachmeler	Coronal polarization forward modeling
	10:10 - 10:40	Adam	Szabo	The Solar Probe Plus Mission
Coffee				
	11:10 - 11:30	Vincenzo	Carbone	Where does the "promising avenue" indicated by E. Marsch 20 years ago lead to
	11:30 - 11:50	Yuriy	Voitenko	Linking turbulence and velocity distributions of solar wind particles
	11:50 - 12:30	Marco	Velli	What is the perfect future solar mission?
Lunch	12:45			
End of Meeting				

	POSTERS		first author		
	Nr.				
	P-01	Michael K.	Bird		Coronal radio sounding experiments with the ESA spacecraft MEX, VEX and ROSETTA
	P-02	A. I.	Efimov		Radio sounding observations: quasi-periodic frequency fluctuations in the corona
	P-03	Joris	Verbiest		Probing the Solar Wind and Magnetic Field with Pulsars
	P-04	Yudish	Ramanjooloo		The structure of the inner heliosphere as revealed by amateur astronomers' images of comets
	P-05	Shuo	Yao		Identification of Prominence Material in the Magnetic Cloud
	P-06	Andreas	Klassen		Solar origin of in-situ mildly relativistic electron spikes
	P-07	Jiansen	He		Nature of kinetic-scale fluctuations in solar wind turbulence
	P-08	Romana	Ratkiewicz		The SW-LISM Interaction: global modeling?
	P-09	Redouane	Mecheri		Ion cyclotron waves in the open solar corona
	P-10	Daniel	Verscharen		Large-amplitude Alfven waves and their coupling to compressive modes
	P-11	Jaime A.	Araneda		Alfven-cyclotron wave-mode structure: linear and nonlinear properties
	P-12	Yana	Maneva		Wave heating and acceleration of solar wind ions - hybrid simulations
	P-13	Rositsa V.	Topchiyska		Self-induced opacity of hot hydrogen plasma in a model for heating the solar corona
	P-14	Z. D.	Dimitrov		Amplification of slow magnetosonic waves by homogeneous shear flow: Analytical solution
	P-15	Li	Feng		Morphological evolution of a 3D CME cloud reconstructed from three viewpoints
	P-16	Thomas	Wiegelmann		Coronal magnetic field extrapolations to guide solar wind investigations
	P-17	Antonio	Pasqua		Data Analysis in Numerical Models of the Solar Corona
	P-18	Antonio	Pasqua		Derivation of 3D magnetic topology of solar active regions from 2D magnetograms
	P-19	Irina A.	Bilenko		The Formation of High-Speed Solar Wind in Coronal Holes
	P-20	Kuang-Wu	Lee		Bifurcation of collisionless Harris current sheets
	P-21	Eric	Adamson		Energy Release in a Solar Coronal Bright Point Region
	P-22	Yurii V.	Dumin		Self-Sustained Heating of the Transition Region by the Dynamo Processes
	P-23	Dipankar	Banerjee		Propagating disturbances in fan loops as seen from EIS/Hinode & AIA/SDO
	P-24	Girjesh R.	Gupta		Spectroscopic Observations of Propagating Disturbances in Polar Coronal Hole
	P-25	Bhola N.	Dwivedi		On the Observation of a Large Scale Flow in the Solar Atmosphere
	P-26	Werner	Curdt		Explosive events - swirling transition region jets
	P-27	Philippe	Bourdin		Viscous versus Ohmic heating in a MHD coronal model

Abstracts for Talks

In the same order as in the programme.

Presenting author in boldface.

Talks: Wednesday, February 1

From Helios to the Outer Heliosphere - Observational Frontiers

R. F. Wimmer-Schweingruber

Institute for Experimental and Applied Physics, Christian-Albrechts-University Kiel
(wimmer@physik.uni-kiel.de)

Invited. Cut out of the local interstellar medium by the solar wind the giant bubble which we call the heliosphere surrounds us and offers a plethora of often surprising opportunities to study a multitude of physical phenomena. These phenomena range from microscopic physics which changes dramatically between the Sun and the outer reaches of the heliosphere all the way to the macroscopic shaping of the heliosphere and of interaction regions in interplanetary space. In many respects Helios was a pathfinder for new ideas which have shaped our concepts of what we today call heliophysics. Nevertheless, new observations are showing us new aspects and often surprising results. This shows that the story is not over - new observations will reveal hitherto unknown connections between the Sun, heliosphere, and interstellar medium, which will offer us and future generations of scientists unexpected discoveries.

Imaging the Solar Wind in the Corona and Heliosphere

C. E. DeForest and **T. A. Howard**

Southwest Research Institute (howard@boulder.swri.edu)

Contributed. Heliospheric imaging of Thomson scattered sunlight is complementary to the modeling and in situ measurement that have been used to understand the heliosphere to date. Recent advances in background subtraction have created spectacular, photometric imagery from the STEREO/SECCHI instruments, and these types of data are likely to be available for and from Solar Orbiter. Heliospheric imaging yields a quantitative measure of density over large structures and provides understanding of the morphology of features detected in exquisite detail by in situ probes. By tracking individual features from the corona at 5 Rs out to over 1 A.U. as they expand by (typically) 6 orders of magnitude and fade in brightness by over 7 orders of magnitude, we are able to identify positively how coronal features correspond to their in situ counterparts. I will discuss recent results enabled by these data, ranging over: anatomy of coronal mass ejections as they propagate; the magnetic flux balance of the heliosphere; and the origin of variability in the slow solar wind.

Coronal Mass Ejections detected during Radio Sounding Observations with the MEX

M. Hahn[1], S. W. Asmar[2], M. K. Bird[3], B. Häusler[4], M. Pätzold[1], S. Tellmann[1], B. Tsurutani[2], and G. L. Tyler[5]

1: Rheinisches Institut für Umweltforschung, Abteilung Planetenforschung, Universität Köln (matthias.hahn@uni-koeln.de), 2: Jet Propulsion Laboratory, California Institute of Technology, 3: Argelander-Institut für Astronomie, Universität Bonn, 4: Institut für Raumfahrtforschung, Universität der Bundeswehr München, 5: Department of Electrical Engineering, Stanford

Contributed. The radio sounding technique is a powerful tool to investigate the large-scale structure of the solar corona when a radio transmitter is located near superior solar conjunction. Mars Express, in orbit about Mars, underwent solar conjunctions in August/September 2004, October/November 2006, December/January 2008/09 and from December 2010 to March 2011. As part of the Radio Science Experiment MaRS radio-sounding measurements were recorded using the dual-frequency downlinks of the spacecraft during solar conjunctions. The transmitted radio signals at X-band (8.4 GHz) and S-band (2.3 GHz) propagated through the dense plasma of the solar corona. Changes in carrier frequency and propagation delay reveal the large-scale coronal structure, the electron content and plasma turbulence as a function of distance from the Sun. MaRS observed several Coronal Mass Ejection (CME) events crossing the radio ray path. A detailed interpretation of these events is presented. A CME-model was developed and adapted to the measured electron content in order to derive information on the electron density, plasma velocity and spatial structure of component CME features. Results of various simulations are presented and compared with SOHO/LASCO data.

Heavy Ions in the Solar Wind

S. A. Livi

Southwest Research Institute (slivi@swri.edu)

Invited. Hydrogen and Helium constitute more than 99.9% of the solar wind and the plasma processes governing and ruling the solar wind plasma are by far dominated by those two species. Consequently ions other then protons and alphas, the so-called "heavy ions", are also often referred to as "minor ions" they do not affect the dynamics of the system, but act as co-participants in the flow. Exactly here lies their importance: like leaves in the river, they do not affect the flow, but are powerful indicator and tracers of the physical phenomena that acted or still act on the plasma. First and foremost, the charge state of the heavy ions is established very low in the corona, and does not change during propagation: heavy ions carry the imprint of the electron temperature in the region the plasma detached from the Sun. Also, the easiness of ionization (known as First Ionization Potential) affects how long the particles were subject to the gravitational potential of the Sun, before been accelerated by electromagnetic forces, which sets powerful constraints on the dynamic of the early solar wind accelerations. The characteristics of the distribution functions of the ions reveal also the plasma processes that are at work during the expansion: heavy ions travel faster than protons, up to the Alfvén speed; the temperature is proportional to the mass of the ion; and present a large anisotropy, clear marker of the conservation of magnetic moment. All plasma characteristics of the heavy ions are moderated by Coulomb collisions and enhanced by wave-particle interaction, making this ions an excellent laboratory for studying the processes that regulates solar wind acceleration and expansion.

Ion Heating and Turbulence Dissipation in Solar Wind

S. Bourouaine and E. Marsch

Max Planck Institute for Solar System Research (bourouaine@mps.mpg.de)

Contributed. We study the correlation between the ion temperature anisotropy and the wave power of the magnetic field fluctuations using Helios measurements. It is found that both the normalized differential alpha-proton speed and the proton temperature anisotropy increase when the relative wave power is growing. However, it turned out that the alpha temperature anisotropy does positively correlate with the normalized wave power only when the value of the ion differential speed is bellow 0.5 V_A (where V_A is the Alfvén speed). Also, in this presentation we show the radial evolution of the power spectral density of the magnetic field from 0.3 to 0.9 AU. We found that the high-frequency spectral break does not strongly change with the heliocentric distance. Furthermore, when we take into account the 2D nature of the turbulence, we show that the proton inertial scale matches the spatial scale corresponding to the break.

The anisotropic Cascade of Solar Wind Turbulence beyond MHD Scales

D. Verscharen[1,2], E. Marsch[1], U. Motschmann[2,3], and J. Müller[2]

1: Max Planck Institute for Solar System Resarch (verscharen@mps.mpg.de), 2: Technical University Braunschweig, 3: DLR Institute for Planetary Resarch

Contributed. The nature of solar wind turbulence in the dissipation range at scales much smaller than the large MHD scales remains under debate. Here a two-dimensional model based on a hybrid code is presented, which treats massive ions as particles obeying the kinetic Vlasov equation and massless electrons as a neutralizing fluid. Up to a certain wavenumber in the MHD regime, the numerical system is initialized by assuming a superposition of isotropic Alfvén waves with amplitudes that follow the empirically confirmed spectral law of Kolmogorov.

Under typical solar wind conditions, anisotropic turbulence develops in the kinetic regime, where also dissipative effects occur. Depending on the direction of propagation with respect to the background magnetic field, the fluctuations can be interpreted as a superposition of different normal modes. Spectral analysis in the parallel direction of propagation reveals a cascade of left-handed Alfvén/ion-cyclotron waves and right-handed fast-mode and whistler waves. Perpendicular to the background field, a broad turbulent spectrum is found to be built up of fluctuations having a strong compressive component. Ion-Bernstein waves seem to be possible normal modes in this propagation direction. Also signatures of short-scale pressure-balanced structures (very oblique slow-mode waves) are found.

Origin and Acceleration of Fast Solar Wind

C. Tu

Peking University (chuanyitu@pku.edu.cn)

Invited. This talk will review our previous work to show our understanding on the heating, acceleration and the origin of the solar wind, including the following results: 1. The observational evidences of the solar wind heating and the proton-cyclotron wave resonance; 2. The quasi-linear theory for ion-cyclotron resonance heating mechanism; 3. The WKB-like turbulence theory for describing energy cascading in Alfvénic fluctuations; 4. The solar wind model with describing wave spectrum evolution based on the WKB-like turbulence theory; 5. Solar wind model with sweeping energy supply; 6. Observation on initial out-flow of the solar wind; 7. The solar wind model with initial mass supply by magnetic loop and funnel reconnection driven by super-granular convection. Finally we will address possible future works with observations by the Solar Orbiter.

In-situ Observations on anisotropic Turbulence

R. Bruno

Instituto di fisica dello Spazio Interplanetario, INAF (roberto.bruno@ifsi-roma.inaf.it)

Invited. In the presence of a background magnetic field MHD incompressible turbulence becomes anisotropic. As a matter of fact, the main effect produced by the presence of this field is to generate an anisotropic distribution of wave vectors due to the fact that the characteristic time for the non-linear coupling depends on the angle between the wave vector and the background field.

Anisotropic turbulence has been observed in laboratory plasmas and reverse pinch devices and has been studied both theoretically and through numerical simulations.

In this presentation the anisotropic character of turbulence in solar wind fluctuations, in power and k vector, is reviewed from large to small scales along the inertial range and beyond the ion cyclotron frequency, in the so called dissipation range. In particular, the anisotropic character of these fluctuations will be reviewed, according to the available literature, for different solar wind conditions, in the ecliptic, out of the ecliptic and for different heliocentric distances.

On the Origin of the 1/f Spectrum in the Solar Wind

A. Verdini[1], R. Grappin[2], and M. Velli[3]

1: Royal Observatory of Belgium (verdini@oma.be), 2: LPP, Ecole Polytechnique and LUTH, Observatoire de Paris, 3: Jet Propulsion Laboratory, California Institute of Technology

Contributed. We present results of numerical simulations in which the low frequency 1/f spectrum is a natural outcome of the turbulent dynamics inside the sub-Alfvénic solar wind. The mangetic field is assumed to be parallel to the radial expanding solar wind, a situation that holds at that short heliospheric distance and fluctuation of short periodicity (600 sec) are injected at the base of the chromosphere. The resulting spectrum that is advected by the solar wind outside the Alfvénic critical point has distinct properties in the parallel and perpendicular directions.

The perpendicular spectrum is a power-law with a slope close to the Kolmogorov 5/3. The parallel spectrum has a double-power-law with slope approximately -1 and -2 at low and high frequencies respectively. The formation of the 1/f spectrum is based on the recycling of Alfvénic turbulence between the transition region and the Alfvénic critical point, a mechanism that works more efficiently for weak turbulence.

We speculate that the double-power-law spectrum measured by Helios at 0.3 AU, where the average magnetic field is not aligned with radial direction, results from the combination of the different spectral slopes. At low frequency the parallel spectrum dominate with its charcteristic 1/f shape, while at higher frequencies its steep spectral slope (-2) is masked by the more energetic perpendicular spectrum (with a -5/3 slope). In this view the 1/f spectrum is a signature of a weak turbulence activity in the corona.

ROMA (Rank-Ordered Multifractal Analysis) of Intermittency in Space Plasmas

T. Chang[1] and C. Wu[2]

1: Massachusetts Institute of Technology (tom.tschang@gmail.com), 2: University of California at Los Angeles

Contributed. For intermittent turbulence, one may visualize the fluctuations to be composed of many types, each being characterized by a particular fractal dimension. Two questions arise: (i) what are the different types of fractal dimensions? and (ii) how are they distributed in the turbulent medium? Recently, a new technique of analyzing intermittent fluctuations has been developed to specifically address these questions (Chang and Wu, Phys. Rev. E, Rapid Communications, 77, 045401(R), 2008). The technique, known as Rank-Ordered Multifractal Analysis (ROMA), retains the spirit of the structure function analysis and combines it with the idea of one-parameter scaling of monofractals.

We shall demonstrate (Wu and Chang, Nonlinear Processes of Geophysics, 18, 261, 2011) that ROMA maps the complete set of non-self-similar probability distribution functions (PDFs) of intermittent fluctuations and at the same time determines the fractal spectrum in terms of the concept of generalized crossover invariant functions, connecting the understanding of intermittent turbulence one-step closer to the concept of the dynamical renormalization group (DRG). Examples in numerical simulations and space observations (including those from the solar wind and corona EUV emissions) will be provided.

Talks: Thursday, February 2

Connecting the Solar Wind to the Corona

S. Cranmer

Harvard-Smithsonian Center for Astrophysics (scranmer@cfa.harvard.edu)

Invited. The last decade has seen significant progress toward identifying and characterizing the processes that heat the corona and accelerate the solar wind. Much of this progress has come about because new measurements are diminishing the traditional gap between solar physics (i.e., near-Sun astronomy) and interplanetary space physics. Through the work of people like Eckart Marsch, these two communities are becoming increasingly aware of the value of each other's data and theoretical insights. This presentation will give an overview of some of the ways that connections between the Sun and the heliosphere are leading to new answers to old questions. First, I will summarize how the 3D, topologically complex magnetic field of the solar corona is literally "connected" to the large-scale open magnetic field in interplanetary space. All existing techniques for the prediction of space weather are limited by gaps in our knowledge of how the ever-changing magnetic field can be traced between the Sun and the heliosphere. Second, I will give a brief overview of recent controversies about whether or not the MHD waves and turbulence detected at 1 AU are consistent with the existence of sufficiently strong fluctuations in the corona to heat and accelerate the plasma. Finally, I will describe some of the commonalities in collisionless kinetic physics between the corona and the solar wind, and how my own journey in this field has been influenced by standing on the shoulders of giants from Lindau.

Morphology, dynamics and plasma parameters of plumes and inter-plume regions

K. Wilhelm

Max Planck Insitute for Solar System Research (wilhelm@mps.mpg.de)

Contributed. Coronal plumes, which extend from solar coronal holes (CHs) into the high corona and — possibly — into the solar wind (SW), can now continuously be studied with modern telescopes and spectrometers on spacecraft, in addition to investigations from the ground, in particular, during total eclipses. Despite the large amount of data available on these prominent features and related phenomena, many questions remained unanswered as to their generation and relative contributions to the high-speed streams emanating from CHs. An understanding of the processes of plume formation and evolution requires knowledge of the physical conditions at the base of CHs, in plumes and in the surrounding inter-plume regions (IPRs). More specifically, information is needed on the magnetic field configuration, the electron densities and temperatures, effective ion temperatures, non-thermal motions, plume cross-sections relative to the size of a CH, the plasma bulk speeds, as well as any plume signatures in the SW. This presentation summarizes the results and conclusions of a study report by an International Team at ISSI, Bern, 2007 to 2010 published in Astron. Astrophys. Rev. (2011) 19:35. Members of the study team were L. Abbo, F. Auchère, N. Barbey, L. Feng, A.H. Gabriel, S. Giordano, S. Imada, A. Llebaria, W.H. Matthaeus, G. Poletto, N.-E. Raouafi, S.T. Suess, L. Teriaca, Y.-M. Wang and the author. Stereoscopic observations allowed us to perform three-dimensional reconstructions of plumes. Multi-instrument investigations carried out during several campaigns led to progress in many areas, such as plasma densities, temperatures, plume structure and the relation to other solar phenomena. However, details of plume generation process(es) and some aspects of the interaction of plumes with the SW are still open questions that will hopefully find answers with the help of Solar Orbiter observations.

2D Hybrid Models of expanding Solar Wind H^+-He^{++} Plasma Heating

L. Ofman[1,2], Y. Maneva[1,2], and A. F. Viñas[2]

1: Catholic University of America (leon.ofman@nasa.gov) 2: NASA Goddard Space Flight Center

Contributed. We study the heating and the acceleration of multi-ion solar wind plasma using 2D hybrid model with the expanding-box approach. In the hybrid model the protons and heavy ions are treated kinetically as particles, while the electrons are included as neutralizing background fluid in an expanding coordinate system. This approach allows modeling the small scales of ion kinetic evolution without the limitations of short electron timescales while taking into account the large-scale expansion. Input turbulent Alfvénic wave spectrum guided by observation is introduced at the time-dependent boundary in inhomogeneous background density structure. The effects of He^{++} ion beams and initial anisotropy as the source of ion-cyclotron waves that heat the plasma are also investigated in the expanding solar wind. The parametric dependence of the perpendicular heating and the temperature anisotropy evolution is studied with the 2D hybrid model. The effects of solar wind expansion on the self-consistent wave spectrum produced in various solar wind plasma regions are investigated. Comparing the results of the model to observations provides improved constraints on multi-ion expanding solar wind plasma wave heating requirements.

Electron Transport in the Fast Solar Wind

H. Smith[1], E. Marsch[2], and P. Helander [1]

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Contributed. A conventional fluid approach is in general insufficient for a correct description of electron transport in weakly collisional plasmas such as the solar wind. The classical Braginskii or Spitzer-Härm theory is only valid when the Knudsen number (mean free path divided by length scale of density or temperature variation) is less than $\sim 10^{-2}$. Despite this, the classical heat transport coefficient is widely used in situations with relatively long mean free paths. For realistic Knudsen numbers in the solar wind, the electron distribution function develops suprathermal tails, and the departure from a local Maxwellian can be significant at the energies which contribute the most to the heat flux moment. To accurately model this a kinetic approach is required, and different techniques have been used previously, e.g. particle simulations [Landi et. al 2003, AA, 400, 769], spectral methods [Pierrard et. al 2001, JGR, 106, 29305], the 16 moment method [Lie-Svendsen et. al 2001, JGR, 106, 8217], and approximation by kappa functions [Dorelli et. al 2003, JGR, 108, 1294].

In the present study we solve the Fokker-Planck equation for electrons in one spatial dimension and two velocity dimensions. The equation is solved by means of a finite element method in energy and pitch-angle, and finite differences in the spatial dimension. The ion temperature and density profiles are assumed to be known, but the electric field is calculated self-consistently to guarantee quasi-neutrality.

The numerical calculation enables us to determine quantitatively how much lower the heat conduction is than what the high-collisionality theory predicts. The heat flux is only around half the Braginskii value, a result which would be important for ion modelling. The thermal force from collisions between electrons and ions is also seen to be around half that of the high-collisionality theory. The particle and heat fluxes are sensitive to the applied boundary condition at the outer boundary and to the ion coronal temperature profile. Moreover, the heating of electrons purely by collisions with ions is inefficient because of the low collisionality. To obtain coronal electron temperatures of $\sim$1 MK one needs very hot ($\sim$3 MK) ions.

Particle Acceleration and Plasma Kinetics in the Corona and Wind

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Invited. The photosphere of the Sun is covered by a network of granulations and supergranulations. At the boundaries of the supergranular cells, strong magnetic fields are localized. These strong magnetic fields diverge if they penetrate into the corona and form coronal funnels. Due to small scale magnetic reconnection at the roots of the funnels, electromagnetic waves are generated there and, subsequently, travel along the magnetic field lines in the corona and into the interplanetary space. The resonant interaction of theses waves with the ions and protons on one hand and the electrons on the other hand leads to the heating of the protons and ions in the corona and the acceleration of the solar wind as well as to the formation of suprathermal electrons in the solar wind. All these effects were observed by in-situ measurements of space missions in the last decades. Thus, the heating of the corona, the acceleration of the solar wind and the generation of suprathermal electrons are caused by a common kinetic plasma mechanism. This process happens in the quiet corona and, consequently, can also appear in other stellar coronae.

Energy-dependent Electron Distributions in Flare Loops

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Contributed. Using Ramaty High Energy Solar Spectroscopic Imager (RHESSI) observations and the electron visibility analysis, we obtain not only the photon maps but also the inversed electron maps of solar flares. The size of extended flare loop structures as a function of photon/electron energy has been studied. The physical characteristics of energy dependent acceleration and transport processes of nonthermal electrons in solar flares has been investigated.

Suprathermal Electron Production in the quiet Solar Corona

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Contributed. Solar wind electron velocity distribution functions (VDFs) no only contain a thermal core, but also an extended suprathermal halo and anti-sunward beam or "strah". This raises the question how suprathermal electrons are produced in the solar corona or wind. Solar flares are well known for releasing high fluxes of energetic electrons, but the suprathermal population also exists under quiet solar conditions. A kinetic model is presented for the generation of suprathermal electrons under quiet solar conditions. It is based on resonant interaction between electrons and whistler waves. Results are presented for the closed volume of a coronal loop, starting from a Maxwellian electron VDF. The whistler waves enter the loop through the footpoints, and their dispersion relation and absorption inside the loop are considered. Their spectrum corresponds to the high-frequency tail of wave spectra that are discussed for coronal heating. So coronal heating and suprathermal electron production are based on the same process.

Crossing the Transition Region

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Invited. The solar transition region (TR) plays an important role in solar wind origin and coronal heating. Recent high-resolution observations made by SOHO, TRACE, Hinode and SDO indicate that the TR is highly nonuniform and magnetically structured. Through a combination of spectroscopic observations and magnetic field extrapolations, the TR magnetic structures and plasma properties have been found to be different in coronal holes and in the quiet Sun. In active regions, the TR density and temperature structures also differ in sunspots and the surrounding plage regions. The emission of hydrogen Lyman lines, which originates from the lower TR, has also been intensively investigated in the recent past. Observations show clearly that the flows and dynamics in the middle and upper TR can greatly modify the Lyman line profiles. Recently, both EUV imaging and spectroscopic observations revealed the presence of ubiquitous high-speed outflows in the TR and corona. While the SDO/AIA observations clearly reveal cooling downflows in the TR. These observations suggest that the TR and coronal emission consists of three components: a nearly stationary background emission component, a high-speed upflow component resulting possibly from impulsive heating of the chromosphere, and a slow cooling downflow component. Such a scenario is a natural result of plasma circulation in the TR and corona. It is probably the relative contributions of the three components that produce the previously reported temperature dependence of Doppler shift and non-thermal line width in the TR.

Coronal Holes observed by SUMER/SOHO, EIS/Hinode and AIA/SDO

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Contributed. Coronal holes as source regions of the fast solar wind have been extensively investigated by analyzing UV/EUV spectroscopic data obtained with the high-resolution spectrometer SUMER during the SOHO era. Blue shifts deduced from the Ne VIII line ($T_e \approx 6.3 \times 10^5$ K) predominate in the coronal hole. Larger-scale outflows are mainly associated with the network where unipolar magnetic field dominates. Red or less blue shifts are found in EUV bright points with obvious bipolar photospheric magnetic features underlying. Apparent small-scale blueshifts are also found in Dopplergrams deduced from transition region lines formed at a temperature below 5×10^5 K (although on average they are red shifted). Larger-scale blueshifts with velocity of ~10 km/s deduced from the line profile of Ne VIII are identified as evidence that the wind originates in the chromospheric network (open magnetic funnels). However, the spectral lines used in these studies are mainly obtained in the transition region with lower time resolution and the behaviours of the nascent solar wind at higher temperatures and with high time resolution have not yet been understood. Recent spectroscopic and imaging observations with instruments on board Hinode and SDO have provided further information about the coronal holes seen in EUV lines formed in the solar corona. Some interesting results, e.g., ubiquitous episodic outflows (jets) in plume-like structures, are found from the new observations. These new results indicate that a combining analysis of both spectroscopic and imaging data may be very crucial to understanding the nature of the source region of the solar wind. In this contribution, we first review our previous studies of coronal holes observed by SUMER, and then discuss further results obtained by high-resolution imaging observations with AIA/SDO and spectroscopic observations with EIS/Hinode.

Processes of turbulent Cascade in large-scale magnetic Reconnection

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Contributed. Magnetic field reconnection is now generally accepted as the key mechanism for energy release in solar flares and other eruptive events in astrophysical and space plasmas. However, direct application of magnetic-reconnection theory to the physics of solar flares (and other large-scale events) faces a crucial issue for a long time: All known micro-physical processes leading to the change of magnetic field topology (i.e. the reconnection) require very thin current sheets (~1 m in the solar corona). On the other hand, the typical flare current-layer width, estimated either from observations or from the dimensional considerations, is about six orders of magnitude larger. This duality is reflected also in the solar-flare observations, which exhibit both coherent large-scale (~10 Mm) dynamics and signatures of the micro-scale, chaotic energy release, at the same moment. It is thus clear that some mechanisms of consecutive fragmentation of the current density (and corresponding magnetic field) structure have to play a role.

In this contribution we aim at identifying all such possible processes and studying some of them in more detail. Our recent research has shown that the cascade towards small scales is the result of mutual positive feedback between the Lorentz-force driven instabilities (such as tearing and the fragmenting coalescence), and their flow- and pressure-field driven counterparts (typically Kelvin-Helmholtz and ballooning instabilities).

From the Photosphere to the Solar Wind: 2D MHD Simulation of Alfvén Waves

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Contributed. The solar wind emanates from the hot and tenuous solar corona. Earlier studies using 1.5 dimensional simulations show that Alfvén waves generated in the photosphere play an important role in coronal heating through the process of non-linear mode conversion. In order to understand the physics of coronal heating and solar wind acceleration together, it is important to consider the regions from photosphere to interplanetary space as a single system. We performed two-dimensional, self-consistent magnetohydrodynamic simulations, covering from the photosphere to the interplanetary space for the first time. We carefully set up the grid points with spherical coordinate to treat the Alfvén waves in the atmosphere with huge density contrast, and successfully simulate the solar wind streaming out from the hot solar corona as a result of the surface convective motion. The footpoint motion excites Alfvén waves along an open magnetic flux tube, and these waves traveling upwards in the non-uniform medium undergo wave reflection, nonlinear mode conversion from Alfvén mode to slow mode, and turbulent cascade. These processes leads to the dissipation of Alfvén waves and acceleration of the solar wind. It is found that the shock heating by the dissipation of the slow mode wave plays a fundamental role in the coronal heating process whereas the turbulent cascade and shock heating drive the solar wind.

Where to go beyond MHD?

E. Priest

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Invited. This review talk will first summarise the various MHD approaches to modeling the solar wind, their successes and limitations. Then it will describe the nature of the MHD equations and where they fail. Finally, an account of some attempts to go beyond single-fluid MHD will be presented including two-fluid and kinetic approaches.

Future Science with Solar Orbiter

R. Marsden

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Invited. Understanding the connections and the coupling between the Sun and the heliosphere is of fundamental importance to addressing one of the major scientific questions of ESA's Cosmic Vision 2020 programme: "How does the Solar System work?" The heliosphere also represents a uniquely accessible domain of space, where fundamental physical processes common to solar, astrophysical and laboratory plasmas can be studied under conditions impossible to reproduce on Earth, or to study from astronomical distances. The results from missions such as Helios, Ulysses, Yohkoh, SOHO, TRACE, RHESSI and STEREO, as well as the recently launched SDO mission, have formed the foundation of our understanding of the solar corona, the solar wind, and the three-dimensional heliosphere. Each of these missions had a specific focus, being part of an overall strategy of coordinated solar and heliospheric research. However, an important element of this strategy has yet to be implemented. None of these missions have been able to fully explore the interface region where the solar wind is born and heliospheric structures are formed with sufficient instrumentation to link solar wind structures back to their source regions at the Sun. This is the overarching goal of Solar Orbiter, the first Medium-class mission of the Cosmic Vision programme. Planned for launch in January 2017, the Solar Orbiter mission will be carried out in collaboration with NASA. With previously unavailable observational capabilities provided by the powerful combination of in-situ and remote sensing instruments, and the unique inner-heliospheric mission design specifically tailored for the task, Solar Orbiter will address the central question of heliophysics: How does the Sun create and control the heliosphere? In this paper we present a brief overview of the mission, and examine those areas where Solar Orbiter is expected to make major contributions to furthering our understanding of the Sun and heliosphere as an integrated system.

PHI on Solar Orbiter

S. Solanki

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Contributed. The Solar Orbiter will be the next solar mission of the European Space Agency. Among its suite of instruments is the Polarimetric and Helioseismic Imager, or SO/PHI for short. SO/PHI will measure the magnetic fields at the solar surface, both at high resolution and, alternatively, over the full solar disk. It will in addition be able to measure surface flows, as well as subsurface structure and flows through the technique of local helioseismology. SO/PHI will play a central role in making Solar Orbiter reach its science goals. The instrument is currently in the design phase. In this presentation, the science to be done with PHI, as well as the implementation of the instrument will be discussed, providing the listeners with an up-to-date picture of the status of the instrument.

Coronal Polarization forward Modeling

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Contributed. With the deployment of the Coronal Multichannel Polarimeter (CoMP) at Mauna Loa Solar Observatory, daily coronal polarization measurements are now available. Full inversion of these measurements is an ill-posed problem, but the forward method, whereby synthetic data is created from numerical models, is an extremely useful tool for this type of data. Our forward technique can be used with both local and global models to obtain quantitative comparisons between models and observations of the coronal magnetic field. This type of model validation is extremely important for many reasons including the fact these global models are often used as lower boundary conditions for solar wind studies. We will introduce the coronal polarization data, present our forward technique, and show some scientific results from model-observations comparisons.

The Solar Probe Plus Mission

A. Szabo

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Invited. NASA is in the process of designing the Solar Probe Plus mission that will approach the Sun within 9.5 solar radii near the ecliptic plane. The mission will have to overcome a number of technical challenges, such as surviving the extreme thermal environment near the Sun while making high time resolution solar wind plasma, magnetic field and energetic particle observations. The mission design, selected instrumentation and observational approaches will be discussed. The Solar Probe Plus mission is scheduled to launch in 2018, within a year of the Solar Orbiter launch and thus the two missions will have natural opportunities to work together and to enhance their combined measurements.

Where does the “promising Avenue” indicated by E. Marsch twenty Years ago lead to

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Contributed. In a short review paper entitled “Introduction to kinetic physics waves and turbulence in solar wind” at Solar Wind 7 in 1991, E. Marsch said “The recent work by Burlaga (1991) opens in my mind a very promising avenue to analyse and understand solar wind turbulence from a new theoretical vantage point”. I would like to review, where the avenue indicated by Eckart leads us twenty years later and what we learned on solar wind turbulence.

Linking Turbulence and Velocity Distributions of Solar Wind Particles

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Cluster in-situ observations of solar wind turbulence have revealed that the turbulent cascade is not terminated at the so-called high-frequency spectral break, but extends further into the kinetic-scale range. Moreover, polarization tests and k-filtering analysis indicate that kinetic-scale turbulence is dominated by highly oblique kinetic Alfvén waves (KAWs). Nonlinear interactions among KAWs produce different spectra in weakly and strongly dispersive sub-ranges [1]. These KAWs interact with particles efficiently and give rise to various non-thermal features in the particle velocity distributions. In particular, the proton (and heavier ions) distributions can be affected by KAWs and deviate significantly from maxwellians in the velocity range covered by KAW phase velocities [2]. We analytically and numerically investigate a causal relationship between turbulence and velocity distributions in the solar wind in the framework of a kinetic model. The results demonstrate that proton beams and extended anti-sunward tails observed in the solar wind are a natural consequence of kinetic-scale alfvénic turbulence.

[1] Voitenko, Y. and de Keyser, J.: Turbulent spectra and spectral kinks in the transition range from MHD to kinetic Alfvén turbulence, Nonl. Proc. Geophys., Vol. 18, pp. 587-597 (2011).
[2] Pierrard, V. and Voitenko, Y.: Velocity Distributions and Proton Beam Production in the Solar Wind, TWELFTH INTERNATIONAL SOLAR WIND CONFERENCE. AIP Conference Proceedings, Vol. 1216, pp. 102-105 (2010).

What is the perfect future Solar Mission?

M. Velli

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Invited. Space and ground-based exploration of the Sun and Heliosphere have improved our understanding of the solar environment and its interaction with the planets and interstallar medium enormously. Missions for which Prof. E. Marsch provided motivation, inspiration, and enormous momentum, such as Solar Orbiter in Europe, but also Solar Probe Plus in the USA, are now in the implementation phase. This presentation will start from such future exploratory missions and attempt to outline some of the outstanding questions heliophysics, together with ideas for future ways to address them.
Such questions include: magnetic field evolution from the photosphere into the corona and the detailed energy balance in these crucial solar atmospheric layers, which requires magnetic field measurements in the chromosphere and corona; the structure of flows in the solar interior and their variations, and the seat (seats) of the solar dynamo, requiring vector measurements of flows and fields from multiple vantage points; and the space weather requirements of forecasting solar eruptions and the geo-effectiveness, with the associated questions of particle acceleration and transport, requiring long-living observatories situated in a stable Earth-Sun-Satellite configuration in interplanetary space.

Abstracts for Posters

Use the poster numbers to locate the respective poster.

Presenting author in boldface.

Posters

P-01: Coronal Radio sounding Experiments with the ESA Spacecraft MEX, VEX and ROSETTA

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Coronal radio sounding experiments were carried out using the S-band (2.3 GHz) and X-band (8.4 GHz) signals of the ESA Mars Express (MEX), Venus Express (VEX) and Rosetta (ROS) spacecraft during their recurring superior conjunctions. Differential Doppler and Ranging measurements were taken during these opportunities, yielding information on the large-scale structure of the coronal electron density distribution and its variations, including fluctuations on time scales from seconds to hours. The radio propagation path was mostly confined to the low latitude regions of the corona (predominantly slow solar wind) because of the solar conjunction geometry. The mean frequency fluctuation and total electron content are determined as a function of heliocentric distance and are found to be consistent with previous results obtained with Ulysses and Galileo.

P-02: Radio sounding Observations: quasi-periodic Frequency Fluctuations in the Corona

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Coronal radio sounding experiments were carried out using the radio signals of the spacecraft Ulysses, Galileo, Mars Express, Venus Express, and Rosetta over the years 1991-2009. Evidence for a quasi-periodic component (QPC) is occasionally found in the radio frequency fluctuation spectra derived from this large volume of observational data. The spectral density of the QPC is typically a factor of 3-4 higher than the expected power-law background level. The characteristic period of the spectral density peak ranges from 3 to 8 minutes and is sometimes accompanied by a second harmonic. The QPC are observed in about 20% of the spectra at heliocentric distances in the range 3-40 solar radii, both in equatorial regions and at high heliographic latitudes. It is argued that the QPC are associated with fast MHD waves generated locally via nonlinear interactions with 5-min band Alfvén waves propagating mostly upward from the coronal base.

P-03: Probing the Solar Wind and magnetic Field with Pulsars

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Radio waves are affected by ionised plasmas in two ways: firstly, the charged plasma particles cause dispersion of the radio waves, making photons emitted at higher frequencies arrive later than their counterparts emitted at lower frequencies. Secondly, the polarisation vector of the radio emission is rotated in an interaction with the plasma and the magnetic field along the direction of propagation. These two effects are readily observed in pulsar observations because of the pulsed and highly polarised nature of their radio emission. In 2007, Ord et al. performed an initial experiment at relatively high radio frequencies and demonstrated the potential for independently mapping the plasma density and magnetic field of the Sun through pulsar observations. Because both of the described effects strongly scale with observing frequency, any measurement would be far more sensitive at lower frequencies.

We describe the potential for mapping and monitoring the solar plasma density and magnetic field using pulsar observations with the highly sensitive LOFAR radio telescope. Operating between 10 and 240 MHz, with more collecting area than any traditional radio telescope and with multi-beaming capability, LOFAR is ideally suited both for making independent measurements of the solar corona at high precision and for monitoring changes in the plasma density and magnetic field strength. We present the science case, anticipated results and comment on potential problems caused primarily by ionospheric effects.

P-04: The Structure of the inner Heliosphere as revealed by Amateur Astronomers' Images of Comets

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Comets' plasma (type I) tails have been studied as natural probes of the solar wind since the mid-20th century. The appearance, structure, and orientation of a comet's plasma tail are primarily controlled by local solar wind conditions. When the observing geometry is ideal, the direction and dynamics of the plasma tail can reveal temporal and spatial variations in the solar wind flow local to the comet. The plasma tail is generally oriented away from the solar radial direction due to the comet,Äôs orbital motion. Many tail features, such as condensations, kinks, and disconnection events can usually be directly related to changes in the local solar wind. Amateur images of comets obtained with modern equipment and sensors are arguably better in quality than professional images obtained only 2-3 decades ago. We have studied amateur images of several comets, primarily using images of comet C/2001 Q4 (NEAT), from December 2003 to December 2004, and comet C/2004 Q2 (Machholz), between September 2004 and June 2005. For these comets, we compared the aberration angle of their plasma tails with observed and modeled values of near-Earth solar wind data and other heliospheric events. The changing orientation and disturbances in the plasma tail of comet Machholz, NEAT and other comets are used to test the validity of amateur images of comets as a diagnostic tool to understand the temporal and spatial variability of the solar wind in the inner heliosphere. We summarize the results of the study. This analysis technique also offers an opportunity to investigate historical images of comets as they provide snapshots of the variability of solar wind conditions over past solar cycles, e.g. latitudinal variations of the solar wind, heliospheric current sheet sector boundaries and the boundaries of transient features, such as coronal mass ejections and corotating interaction regions. We demonstrate the application of the analysis technique to historical data obtained by both amateurs and professionals.

P-05: Identification of Prominence Material in the magnetic Cloud

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This work presents in situ measurements of three magnetic cloud (MC) events that contain cold high-density material when Helios 2 was located at 0.3 AU on 9 May 1979, 0.5 AU on 30 March 1976, and 0.7 AU on 24 December 1978. In the cold high-density regions embedded in the interplanetary coronal mass ejections we find (1) that the number density of protons is higher than in other regions inside the magnetic cloud, (2) the possible existence of He^{+}, (3) that the thermal velocity distribution functions are more isotropic and appear to be colder than in the other regions of the MC, and the proton temperature is lower than that of the ambient plasma, and (4) that the associated magnetic field configuration can for all three MC events be identified as a flux rope. This cold high-density region is located at the center of the bipolar structure of the MC magnetic field. Specifically, for the first magnetic cloud event on 8 May 1979, a coronal mass ejection (CME) containing an eruptive prominence was previously reported by Solwind (P78-1) observation. It is the first time that prominence ejecta are identified by both the plasma and magnetic field features inside 1 AU, and it is also the first time that the thermal ion velocity distribution functions are used to investigate the microstate of the prominence material. Overall, our results based on in situ measurements are consistent with three-part CME models.

P-06: Solar Origin of in-situ mildly relativistic Electron Spikes

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The Solar Electron Proton Telescope (SEPT) onboard the twin STEREO spacecraft measures electrons and ions in the energy range from 30 to above 400 keV with an energy resolution better than 10%. During 2010 - 2011 SEPT detected a number of usual impulsive electron events showing a prompt intensity onset followed by a long decay, as well several so-called electron spike events.

These spikes are characterized by a very short duration below 10 - 20 min at FWHM, almost symmetric time profiles, velocity dispersion and strong anisotropy revealing a very weak scattering during particle propagation from the Sun to STEREO. Spikes are detected in the energy range below 300 keV, show one-to-one coincidence with type III radio bursts and with narrow coronal EUV jets in active regions.

Using particle, EUV and radio imaging observations we found out that mildly relativistic electrons were accelerated during the same time and at the same location as electrons emitting the accompanying type III radio bursts and coronal EUV jets. Furthermore, the sources of type III radio bursts match very well the location and the trajectory of the associated EUV jet. Applying a particle propagation model we demonstrate that the spike characteristics reflect both, properties of the accelerator and the effects of interplanetary propagation.

P-07: Nature of kinetic-scale Fluctuations in Solar Wind Turbulence

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Solar wind is turbulent plasma filled with various possible plasma wave modes. The wave characteristic of solar wind turbulence in its kinetic scale is crucial in its role of interacting with solar wind ions directly, and becomes a research focus recently. In principle, there are several possible methods to diagnose the wave modes; however, the method efficiency is largely limited in its application to the in-situ measurements. Here, we attempt to identify the wave modes in solar wind turbulence by studying two aspects, magnetic helicity and magnetic compressibility. Three parts are included in our efforts. At first, we for the first time study the angular distribution of normalized reduced magnetic helicity spectra. Two components are revealed, with the major component corresponding to right-hand polarization located around 90° and the minor for left-handedness being around 0° or 180°. Secondly, we reproduce this two-component distribution by assuming a composition of quasi-perpendicular and quasi-parallel Alfvén-cyclotron waves in the solar wind. This successful reproduction demonstrates partly the wave characteristics in solar wind turbulence. In the third part, we further diagnose the wave nature of the major component by studying the magnetic polarization of kinetic-scale fluctuations with $\theta_{VB} \sim 90°$. It is found that the magnetic fluctuation is elliptically polarized with the major axis perpendicular to local background magnetic field direction. This feature seems to favor the presence of oblique Alfvén-cyclotron wave rather than oblique whistler wave. Our findings are based on STEREO in-situ measurements, more features of solar wind kinetic turbulence are expected to be exploited by Solar Orbiter mission.

P-08: The SW-LISM Interaction: global modeling?

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The local interstellar medium (LISM) consists of two components: ionized and neutral. Governed by the local interstellar magnetic field (ISMF), the ionized component of the LISM interacts with the solar wind (SW) plasma, blowing out from the Sun and carrying the Sun's magnetic field through the interplanetary space. Heliosphere, a cavity carved in the interstellar medium remains under an influence of the ISMF and the LISM neutral component. Now we are obtaining more and more data describing the plasma parameters measured by the Voyager 1 and 2 spacecraft operating beyond the termination shock in the solar wind. We have also recently acquired maps of the heliospheric boundaries from measurements of neutral atoms fluxes by the Interstellar Boundary Explorer (IBEX), a heliospheric mission launched in 2008 and operating at the Earth orbit. The future Solar Orbiter (SO) mission will provide the data on the SW from the region between the Sun and the Earth orbit. The challenging task is to construct the 3D MHD time dependent global model describing the SW flow from the Sun to the heliosphere edge using the observational data from the SO, Voyager and IBEX mission.

P-09: Ion cyclotron Waves in the open Solar Corona

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Remote observations of coronal holes have strongly implicated the kinetic interactions of ion-cyclotron waves with ions as a principal mechanism for plasma heating and acceleration of the fast solar wind. In order to study the properties of these waves, a WKB (Wentzel-Kramers-Brillouin) linear perturbation analysis is used in the work frame of the cold collisionless multi-fluid model. A 2-D analytical magnetic-field model is used to define the background plasma describing the open-field funnel regions in coronal holes. The ray tracing formalism is employed to compute the ray path of the waves through the funnel as well as the spatial variation of their properties.

P-10: Large-amplitude Alfvén Waves and their Coupling to compressive Modes

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Large-amplitude Alfvén waves are ubiquitous in space plasmas and a main component of turbulence in the heliosphere. As pump waves, they are prone to parametric instability, by which they can generate ion-cyclotron and acoustic daughter waves. Here, a related process is revisited within the framework of the multi-fluid equations for a plasma consisting of several species. The nonlinear coupling of Alfvén waves to acoustic waves is studied, and a set of compressive and coupled wave equations for the transverse magnetic field and longitudinal electric field is derived for waves propagating along the mean-field direction. Slightly compressive Alfvén waves exert an electromotive force on the particles in association with a longitudinal electric field. The dispersion relation of the plasma waves is determined from a linear stability analysis using a new eigenvalue method that is employed to solve the set of differential wave equations. In the presence of a background Alfvén wave with low frequency and large amplitude, the dispersion branches obtained differ significantly from the situation of a uniform plasma. Due to compressibility, acoustic waves are excited and couplings between various modes occur, and even an instability of the compressive mode.

P-11: Alfvén-cyclotron Wave-Mode Structure: linear and nonlinear Properties

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Kinetic theory and computer simulations are used to describe both parallel and transverse fluctuations in a collisionless, magnetized, and multi-ion plasma. Several features of the linear and nonlinear plasma theory, usually not considered in the literature, are presented and their relevance for the study of the observed stability thresholds of particle velocity distributions, and the differential heating and acceleration of ions in the solar wind are discussed.

P-12: Wave Heating and Acceleration of Solar Wind Ions - hybrid Simulations

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It is well known from in-situ observations that He^{++} ions are accelerated and heated preferentially and flow faster then protons by about an Alfvén speed in the fast solar wind. We carry out hybrid simulations to investigate the kinetic properties of protons and alpha particles in the solar wind. The electrons are considered as a charge-neutralizing massless isothermal fluid, whereas the ions are treated fully kinetically within the particle-in-cell approach. 1D simulations in a homogeneous plasma show that large-amplitude monochromatic waves can preferentially heat and accelerate the solar wind ions up to a more than charge-to-mass temperature ratios. Further analysis show that similar processes still occur when broad-band wave-spectra are introduced in the initial state. Both ion species are heated either by the initial wave-spectra or by the corresponding daughter waves born via parametric instabilities of the initial nonlinear mother wave, and show different beam formations. In addition we have investigated the effect of solar wind expansion, which plays an important role as the solar wind travels away form the Sun. We consider the effects of expansion on wave heating, drift, and initial temperature anisotropy, and find that expansion leads to perpendicular cooling that partially counters the effects of heating, thus affecting the heat input required to account for the observed solar wind plasma properties. Further on, we present the results from 2D hybrid simulations to investigate the effect of the additional spatial dimension, allowing for oblique wave propagation and additional degree of freedom for wave-particle interactions.

P-13: Self-induced Opacity of hot Hydrogen Plasma ‚Äì a Model for Heating the Solar Corona

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One dimensional model for heating of hot hydrogen plasma by Alfvén waves (AW) is numerically analyzed. The transition layer is a direct consequence of the self consistent MHD treatment of AW and wind propagation. Temperature profile and space dependence of the wind velocity are numerically calculated together with wave amplitudes of the magnetic field and velocity. The model gives a natural explanation of the big temperature gradient in the transition layer according to the initial idea of H. Alfvén. For illustrative purposes we used a model of completely ionized hydrogen plasma. Plasma viscosity strongly increases with temperature. A local heating generates local increasing of the viscosity and therefore increasing of the viscous friction which results in heating the plasma even more. This positive feedback creates a sharp transition between the cool domain with negligible absorption of AWs and the hot domain in which the AWs are strongly damped – a self induced opacity with respect to AWs. The static distribution of wind variables (temperature and velocity) are calculated by using the integrals of energy and momentum fluxes. The derived space dependences of spectral AW densities predict considerable intensity of high frequency AWs reflected by the transition layer. We believe that these high frequency AWs will be observed in the chromosphere by the space crafts with forthcoming launchings.

P-14: Amplification of slow magnetosonic Waves by homogeneous Shear Flow: Analytical Solution

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We are presenting the analytical solution for linearized MHD equations for an ideal incompressible fluid. The solution expressed by Heun functions demonstrates that waves can be strongly amplified even without rotation of the fluid. Phase portraits and wave vector dependence of the amplification coefficient are graphically presented. It is speculated that in solar tahocline we can have similar physical condition which can lead to anomalous transport of the angular momentum.

P-15: Morphological Evolution of a 3D CME Cloud reconstructed from three Viewpoints

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The propagation properties of coronal mass ejections (CMEs) are crucial to predict its geomagnetic effect. A newly developed three dimensional (3D) mask fitting reconstruction method using coronagraph imagers from three viewpoints has been described and applied to the CME ejected on August 7, 2010. The CME's 3D localization, real shape and morphological evolution are presented. Due to its interaction with the ambient solar wind, the morphology of this CME changed significantly in the early phase of evolution. Two hours after its initiation, it was expanding almost self-similarly. CME's 3D localization is quite helpful to link remote sensing observations to in situ measurements. The investigated CME was propagating to Venus with its flank just touched STEREO B. Its corresponding ICME in the interplanetary space shows the signature of a magnetic cloud with a preceding shock in Venus Express (VEX) observations, while from STEREO B only shock is observed. We have calculated three principle axes for the reconstructed 3D CME cloud. The orientation of the major axis is in general consistent with the orientation of a filament (polarity inversion line) observed by SDO/AIA and SDO/HMI. The flux rope axis derived by the MVA analysis from VEX indicates a radial-directed axis orientation. It might be that locally only the leg of the flux rope passed through VEX. The height and velocity profiles from the Sun to Venus are obtained. We find that the CME possibly had been incorporated into the solar wind after leaving COR2 field of view and before arriving Venus. A southward deflection of the CME from the source region is found from the trajectory of the CME centre of gravity. We attribute it to the influence of the corona hole where the fast solar wind emanate from.

P-16: Coronal magnetic Field Extrapolations to guide Solar Wind Investigations

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For the interpretation of coronal images it is helpful to have some knowledge of the structure of the coronal magnetic field. Unfortunately we cannot measure the coronal magnetic field directly, but extrapolate photospheric field measurements into the higher solar atmosphere. The resulting magnetic field models have for example been used for the interpretation of Doppler measurements from SOHO/SUMER to investigate the source region of the fast solar wind in equatorial coronal holes as well as plasma flow in active regions. Solar Orbiter will allow us to extend these studies towards polar coronal holes and more sophisticated magnetic field models. We present some recent coronal magnetic field models, e.g. as extrapolated from the Solar Dynamics Observatory and give some outlook about the potential of the Phi-instrument on Solar Orbiter for combining coronal modelling with remote solar wind observations.

P-17: Data Analysis in numerical Models of the Solar Corona

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This work was dedicated to the problem of the physical mechanisms that are responsible for the heating of the solar corona. In particular, I worked on the propagation and dissipation of Alfvénic fluctuations within the magnetic structures of the corona. I studied how such fluctuations interact with spatial inhomogeneities that are intrinsic in these structures, transferring the fluctuating energy to increasingly small scales, where it is dissipated. I calculated the Kolmogorov entropy of magnetic lines in some model structures (this quantity is an indicator of the rate of small scale generation) as well as its statistical distribution as a function of the altitude and of the parameters characterizing the model structure.

P-18: Derivation of 3D magnetic Topology of Solar active Regions from 2D Magnetograms

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Phenomena of the Solar Activity are caused by topological variation of magnetic field related to Active Regions. The interpretation and the modelling of these phenomena cannot have to do without the knowledge of the tridimensional magnetic topology, that spread in the Solar Corona starting from the Photosphere. On the other hand, the measure of magnetic field of the Active Regions is limited at the longitudinal component at photospheric level and from this component with different methods we can extrapolate the tri-dimensional configuration at higher heights. Consolidate numerical methods are based on the tridimensional solution of MHD equations and this implies a long time of calculation also for a region of limited extension. If we consider force-free and quasi-static coronal field, an analytical and numerical method recently proposed allows us to reconstruct the magnetic field starting from observations in different times of the longitudinal component, using stereoscopy of rotation, in a shorter time.
The purpose of this work is the application to different cases of a numerical code, written in IDL language, that implements the stereoscopic method to verify its functionality and the physical congruity of 3D topology reconstructions.

P-19: The Formation of high-speed Solar Wind in Coronal Holes

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The problem of the formation and acceleration of the solar wind is one of the most important problem of modern solar physics. Of particular interest is the study of regularities in the formation of geoeffective high-speed solar wind streams. The high-speed solar wind streams are considered to be associated with the regions of the open configurations of the magnetic fields related to coronal holes. The study showed that the area of coronal holes and their location on the disk depends on the phase of the solar cycle and are determined by the evolution of the global magnetic field. Their location is not random but a cluster structure has been revealed in the time-space organization of coronal holes. The structure of individual coronal hole is determined by photospheric magnetic fields and is various at different altitudes. The fine structure of the photospheric magnetic field at the base of a coronal hole is not uniform. There are regions with "unipolar" magnetic field structure. These "unipolar" regions do not concentrate to the centre of a coronal hole but they may be located in any part of a coronal hole. For long-lived coronal holes the structure and position of such a "unipolar" region may vary within a coronal hole. It is assumed that these regions are the sources of high-speed solar wind streams. A mechanism of the formation of high-speed solar wind in such a coronal hole region is discussed.

P-20: Bifurcation of collisionless Harris Current Sheets

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In the course of the interaction of magnetized plasmas collisionless current sheets are formed throughout the whole heliosphere. Instead of the commonly assumed single-peaked current concentrations, however, frequently bifurcated current sheets (BCS), were observed. For instance, Voyager-2 and Galileo revealed BCS in the Jovian magnetotail [Israelevich et al. 2007, Planet. Space Sci.], near the Earth long-term CLUSTER observations allowed even their statistical investigation [Thompson et al. 2005, GRL].
In order to understand the causes for the formation of BCS we conducted two-dimensional particle-in-cell (PIC-) code simulations. We initialized single-peak (modified Harris) current sheet equilibria, in which a finite background plasma density mimics the environment of collisionless current sheets in the heliosphere. Periodic and Dirichlet boundary conditions are considered, and the simulation resolves the details of the ion inertial length scale, where kinetic plasma processes dominate and turbulent processes are generated. It is found that the single peaked current sheets bifurcate spontaneously. The system entropy monotonously increases indicating that the current sheet system evolves toward a more stable state. Our results hints that a BCS is more stable than the conventionally considered Harris equilibrium, which would explain the frequent observation of BCS in the heliosphere.

P-21: Energy Release in a Solar Coronal bright Point Region obtained through a new parallel Implementation of LINMOD3D

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LINMOD3D is a numerical simulation code for the investigation of the solar coronal plasma dynamics. Due to the strong inhomogeneities and interscale coupling effects inherent to the system, large grids and parallel computing are required in order to ensure proper numerical solution of the field and fluid equations. LINMOD3D has recently been optimized for its more efficient use on parallel computer architectures. This improvement allows a high spatial resolution and a stable run to track a long evolution of the solar atmosphere. We present results of LINMOD3D simulations addressing the effects of various parameter variations on the energy budget of the solar corona.

P-22: Self-sustained Heating of the Transition Region by the Dynamo Processes

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We are going to discuss a possible mechanism of heating the base of the transition region, where solar plasma is moderately ionized. Consideration of a magnetic flux tube filled with a plasma substantially stratified by gravity and driven by upward or downward background flows shows that the ignition of dynamo processes develops most efficiently at the spot of approximate equality between the gyro- and collisional frequencies of the charged particles. Next, due to the heat release and its propagation along the magnetic field lines, the spot of the maximal heat release moves upwards, thereby producing a self-sustained propagation of the entire dynamo process. The temperature increases sharply with height just due to decrease in density (and, consequently, the heat capacity) of the plasma stratified by the gravitational field. This phenomenon may be well applied to model both the individual solar nanoflares and the average effect of their combined action, responsible for heating the chromosphere and the lower part of the transition region.

P-23: Propagating Disturbances in Fan Loops as seen from EIS/Hinode & AIA/SDO

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Active region fan loops in AR 11076 were studied using high cadence spectroscopic observations from EIS/Hinode combined with imaging sequences from AIA/SDO. We find two different groups of periodicities, short (<3 min) and long (>9 min) at two different locations. In shorter range we find oscillations with periodicities as low as 50 s. Shorter periodicities show oscillations in all the three line parameters and the longer ones only show in intensity and Doppler shift but not in line width. Line profiles at both these locations does not show any visible blue-shifted component and can be fitted well with a single Gaussian. Shorter periods does not show any significant peaks in co-spatial and co-temporal data from AIA/SDO, but longer period is clearly observed in both 171Åand 193Åchannels. The apparent propagation speeds were estimated to be 83.5±1.8 km/s and 102.1±3.6 km/s respectively, in these channels. Different mode coupling is proposed to cause the observed short period oscillations in all the three line parameters and the long periods are suggested as signatures of slow magneto-acoustic waves.

P-24: Spectroscopic Observations of propagating Disturbances in polar Coronal Hole

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We focused on long duration spectroscopic observations of polar coronal hole taken on 1997 February 25 by the Solar Ultraviolet Measurements Of Emitted Radiation on board SOHO. Data in the on-disk part of the coronal hole is analyzed to find any signature of propagating waves or high speed up-flows. A clear presence of propagating disturbances with a period of 14 min is found in intensity and Doppler velocity with projected propagation speed about 60 km/s. An intensity enhancement is found to be associated with the blue shifted Doppler velocity. These disturbances are clearly seen in intensity at higher latitudes whereas that in Doppler velocity becomes poor at those higher latitudes. In this presentation, I will discuss the results obtained from the further analysis which may enable us to interpret these propagating disturbances either in terms of waves or up-flows and its implication in the ongoing debate of waves-vs-flows.

P-25: On the Observation of a large Scale Flow in the Solar Atmosphere

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A unique large-scale flow has been observed on 28 July 2011 in a localized region of the solar atmosphere. This large-scale flow lasts for several hours in the observational base-line of the Atmospheric Imaging Assembly (AIA) onboard the SDO spacecraft. The SDO/AIA 304Åfilter sensitive to probing solar plasma around ∼0.1 MK does not carry any signature of this flow. Also, the SDO/AIA filters sensitive to probing the coronal plasma around ∼1.0 MK (e.g., 171Å) show a large-scale field-aligned flow. The SDO/HMI observations do not show any significant magnetic field variation. However, the magnetic field region with a negative polarity seems to be associated with the origin of flow. If we assume a quiet solar atmosphere, the 304Åemission may originate from the upper chromosphere/TR, while other emissions where flows are evident emanate from the inner corona. This indicates that the large-scale flow starts between TR and corona. We also find a possible signature of quasi-periodic activity in this large scale flow. Such a quasi-periodic flow is probably detected for the first time. In turn, it may have significant implications on the existing wave theory model and the origin of supersonic wind flow in the solar atmosphere.

P-26: Explosive Events - swirling Transition Region Jets

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The bi-directed, fast Doppler motion of explosive events observed spectroscopically in the transition region emission is classically interpreted as a pair of jets moving upward and downward from a reconnection site. We discuss the problems of such a model and provide evidence for an alternative scenario to explain the nature of so-called ‘explosive events’. The discrepancy of fast Doppler motion without detectable motion in the image plane is an old, unsolved problem. We now provide the spectral tilt and the jet bifurcation as additional arguments. Both features are indicative of rotational motion in narrow structures. We interpret the bifurcation as the result of rotation of hollow cylindrical structures and demonstrate that such a sheath model can also be applied to explain the nature of the puzzling ‘explosive events’. We find that the spectral tilt, the lack of apparent motion, the bifurcation, and a rapidly growing number of direct observations support an alternative scenario of linear, spicular-sized jets with a strong spinning motion.

P-27: Viscous versus Ohmic heating in a MHD coronal model

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A 3D MHD coronal model driven by photospheric observations is setup to synthesize coronal emission for later comparison with real observations of the coronal structure and dynamics. We start with a hydrostatic stratified atmosphere, a Hinode/SOT magnetogram of a full active region as a lower boundary condition, and drive the magnetic field by photospheric granular motions. The braiding of fieldlines induces currents and leads to Ohmic dissipation that drives the dynamics of the corona and determines its thermal structure. Inclusion of gravity, field-aligned heat conduction, and radiative losses in the energy balance allows to determine the pressure in coronal structures. Coronal emission is synthesized using the CHIANTI atomic database. The comparison between the synthesized X-ray and EUV emission with the observed emission patterns and their Doppler shifts in the lines e.g. Fe VIII, Fe XII, Fe XV, and Ca XVII will provide a crucial test for the assumed heating mechanism, especially the energy input distributed in space and time, e.g. Ohmic heating in nanoflares. Early results are used to investigate the distribution in space of viscous and Ohmic heating.

Graphical overview of scientific programme

From the Heliosphere into the Sun
Sailing Against the Wind

A meeting dedicated to the progress of our understanding of the solar wind and the corona in the light of the upcoming Solar Orbiter Mission

31.Jan – 3. Feb. 2012
Physikzentrum Bad Honnef

10.1.2011	**Wednesday, Feb 1** in-situ science	**Thursday, Feb 2** coronal science	**Friday, Feb 3** where to go from here…
09:00	welcome	*Steve Cranmer* Connecting the wind to the corona	*Richard Marsden* Solar Orbiter
	Robert Wimmer-Schweingruber From Helios to the outer heliosphere (observational frontiers)	Klaus Wilhelm Plume and inter-plume regions	Sami Solanki PHI on SolarOrbiter
	Craig DeForest Imaging the Solar Wind in the Corona and Heliosphere	Leon Ofman 2D Hybrid Models of Solar Wind Plasma Heating	Laurel Rachmeler Coronal polarization forward modeling
10:40	M. Hahn CMEs detected during radio sounding observations	Håkan M. Smith Electron transport in the fast solar wind	*Adam Szabo* Solar Probe Plus
coffee			
11:10	*Stefano Livi* Heavy ions in the solar wind (kinetic processes)	*Gottfried Mann* Particle acceleration and plasma kinetics in the corona and wind	Vincenzo Carbone Where does the "promising avenue" lead to ?
	Sofiane Bourouaine Ion Heating and Turbulence Dissipation in Solar Wind	Jingnan Guo Energy-dependent electron distributions in flare loops	Yuriy Voitenko Turbulence and velocity distributions of solar wind particles
12:30	Daniel Verscharen The anisotropic cascade of solar wind turbulence	Christian Vocks Suprathermal electron production in the solar corona	*Marco Velli* What is the perfect future solar mission?
lunch			
14:30	*Chuan-Yi Tu* Origin and acceleration of the fast wind	*Hui Tian* Crossing the transition region	
		Lidong Xia Coronal holes observed by SUMER, EIS and AIA	
16:10	*POSTERS*	*POSTERS*	
coffee			
16:40	*Roberto Bruno* In-situ observations related to anisotropic turbulence	Miroslav Bárta Turbulent cascade in large-scale magnetic reconnection	
	A. Verdini On the origin of the 1/f spectrum in the solar wind	Takuma Matsumoto photosphere to wind: 2D MHD simulation of Alfven wave	
18:00	Tom Chang ROMA of Intermittency in Space Plasmas	*Eric Priest* Where to go beyond MHD?	
	Conference dinner starting at 18:30	Dinner at 18:30, free evening	

invited talk	contributed talk