SECOND SOLAR ORBITER WORKSHOP

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Contents

Program (Oral program and abstracts) 5

S0 Monday 16 October: Morning Session 7
General status of Solar Orbiter

S1 Monday 16 October: Afternoon Session 11
Determine the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere

S2 Tuesday 17 October 2006: Morning Session 21
Investigate the links between the solar surface, corona and inner heliosphere

S3 Tuesday 17 October 2006: Afternoon Session 29
Explore, at all latitudes, the energetics, dynamics and fine-scale structure of the Sun's magnetized atmosphere

S4 Wednesday 18 October 2006: Morning Session 37
Probe the solar dynamo by observing the Sun's high-latitude field, flows and seismic waves

S5 Thursday 19 October 2006: Morning Session 43
Poster Session

S6 Thursday 19 October 2006: Afternoon Session 45
Open session on science objectives and instrumental issues of Solar Orbiter

S7 Friday 20 October 2006: Morning Session 55
Payload optimization and design aspects

Poster Abstracts 61

List of participants 93

Program

Monday 16 October: Morning Session

S0 General status of Solar Orbiter

09:00-09:15	**Welcome addresses and general information** Kanaris Tsinganos et al.	**S0.0**
09:15-09:45	**Status of the Solar Orbiter within ESA** David Southwood	**S0.1** (Invited lecture)
09:45-10:00	**Solar Orbiter: Mission Goals, Mission Requirements and Technical Challenges** Richard G. Marsden and Donald McCoy	**S0.2** (Invited lecture)
10:15-10:30	**Report on the Solar Orbiter Working Group Activities: Remote Sensing** Richard A. Harrison	**S0.3** (Invited lecture)
10:30-10:45	**Activities of the In-Situ Payload Working Group for Solar Orbiter** Robert F. Wimmer-Schweingruber	**S0.4** (Invited lecture)
10:45-11:15	**Coffee Break**	
11:15-11:45	**International synergies and ILWS relations** M. Guhathakurta	**S0.6** (Invited lecture)
11:45-12:00	**Introduction to the KuaFu project** Chuan-Yi Tu, Rainer Schwenn, Eric Donovan, Jing-Song Wang, Li-Dong Xia, Yong-Wei Zhang	**S0.5**
12:00-12:30	**Questions and Discussion**	
12:30-14:00	**Lunch Break**	

S0.1 Status of Solar Orbiter within ESA

David Southwood
ESA

S0.2 Solar Orbiter: Mission Goals, Mission Requirements and Technical Challenges

Richard G. Marsden[1] and Donald McCoy[2]
[1]Research & Scientific Support Department, ESA, ESTEC, P.O. Box 299 2200 AG Noordwijk, Netherlands
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The Solar Orbiter Mission will study the Sun in greater detail than ever before due the close proximity of the spacecraft as it orbits the Sun. At its closest point, Solar Orbiter will be about 0.22 AU from the Sun, closer than any other satellite to date. In addition to providing high-resolution images of the solar surface, perihelion passes at these distances occur in near co-rotation with the Sun, allowing the instruments to track features on the surface for several days. The mission profile also includes a high-latitude phase that will allow observations from up to 35º above the solar equator. Multiple Venus gravity assist manoeuvres will be employed to increase the inclination of the orbital plane. The combination of near-Sun, quasi-heliosynchronous and high-latitude observations by remote-sensing and in-situ instruments makes Solar Orbiter a unique platform for the study of the links between the Sun and the inner heliosphere. In this paper, we will review the mission goals and the corresponding mission requirements, together with the technical challenges and the status of preparatory work to address those challenges. In doing so, we will highlight those areas that could potentially constrain the scientific performance of the mission.

S0.3 Report on the Solar Orbiter Working Group Activities: Remote Sensing

Richard A. Harrison
Rutherford Appleton Laboratory, UK

The goals of Solar Orbiter require a set of remote sensing instruments which include imaging and spectroscopy across a range of temperatures. The strawman payload thus includes a set of next-generation remote sensing instruments which build on the heritage of SOHO, RHESSI, TRACE and other missions. However, we must recognise the extreme thermal and particle environment, and its variability with the eccentric orbit, and the mission scenario demands the application of low-mass technologies, and the consideration of telemetry and contact restrictions for such a long-distance, encounter mission. The resulting requirements on instrumentation in terms of performance, construction and operation have been widely discussed and assessed. Indeed, the dialogue between the potential instrument teams and the industrial studies has enabled us to develop an excellent global view of this mission as we head towards the Announcement of Opportunity. The evolution of the remote sensing strawman payload will be discussed and the technical challenges outlined in this talk.

S0.4 Activities of the In-Situ Payload Working Group for Solar Orbiter

Robert F. Wimmer-Schweingruber (for the in-situ payload working group)
Extraterrestrial Physics, Institute for Experimental and Applied Physics, University of Kiel, Germany

The in-situ payload for Solar Orbiter will measure the plasma, fields, and particles in the inner heliosphere. It will open new windows to eruptive processes on the Sun and allow us to closely link solar features to the plasma in the inner heliosphere. I will briefly describe the activities of the in-situ payload working group and the strawman payload for Solar Orbiter.

S0.5 International Synergies and ILWS relations

Madhulika Guhathakurta
NASA, Science Mission Directorate/Heliophysics Division

S0.6 Introduction to the KuaFu project

Chuan-Yi Tu[1], Rainer Schwenn[2], Eric Donovan[3], Jing-Song Wang[4], Li-Dong Xia[5], Yong-Wei Zhang[6] on behalf of the KuaFu study team
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The scientific goal is to study globally how energy and mass are transferred at large scales from the solar wind to the magnetosphere during the response of the earth space to solar storms. The mission is designed to observe the complete chain of disturbances from the solar atmosphere to geo-space, including solar flares, CMEs, interplanetary clouds, shock waves, and their respective geo-effects, such as magnetospheric sub-storms, magnetic storms, and auroral activities. The overall mission design will advance our understanding of the basic physical processes underlying space weather, such as the origin of CME, and the energy coupling between the solar wind and the Earth magnetosphere. KuaFu data will also be used for space weather forecasting.

The KuaFu mission is composed of three spacecraft. KuaFu-A is designed to follow a halo orbit at L1 to observe by remote-sensing instruments the storms in the solar atmosphere and their ejections moving in the Sun-Earth space. KuaFu –A will also make in situ measurements of the local plasma, magnetic field and high-energy particles to identify the arrival times and properties of corona mass ejections (CMEs) during solar storms. KuaFu-B1 and KuaFu-B2 are designed to follow an earth polar orbit with an apogee of 8 and perigee of 1.8 radii (from the earth center), and to observe by imaging, continually 24 hours a day and 7 days a week, the northern auroral activities and the changes of the ring current in the radiation belt during magnetic storms. With KuaFu B1 and B2 one can also make observations of the conjugate polar aurora activities. KuaFu-B will also carry a limited suite of in-situ instruments including a fluxgate magnetometer and charged particle detectors.

The KuaFu project is now in the phase of comprehensive review supported by China National Space Administration (CNSA). A careful review of the scientific payload, initial design of the spacecraft platforms, launch, tracking and control, and data transferring will be given. KuaFu is planned to be launched in 2012. KuaFu-A may have a long life time. Possible synergies and common observations with Solar Orbiter may give a complete 3D description of the structures in the solar atmosphere through the chromospheres into the corona. Possible synergies and common observations with SWASE, ESA and FY-3 (CMA) may provide complete observations of the Sun-Earth system including the upper atmosphere and the ionosphere.

Monday 16 October: Afternoon Session

S1	Determine the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere

14:00-14:30 **Status of knowledge after Helios, Ulysses and SOHO of the microstate of the coronal and solar-wind plasma** **S1.1**
Eckart Marsch (Invited lecture)

14:30-14:50 **How is Solar Orbiter going to achieve this goal - science and its requirements, Theoretical aspects** **S1.2**
Marco Velli (Invited lecture)

14:50-15:10 **Solar Orbiter science and its requirements, observational strategies: energetic particles** **S1.3**
Karl-Ludwig Klein (Invited lecture)

15:10-15:40 **Properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere: Instrumental approaches to achieve the required measurements** **S1.4**
Christopher J. Owen, S.D. Bale, A.J. Coates, M.I. Desai, A.N. Fazakerley, T.S. Horbury, P. Louarn, M. Maksimovic, D.J. McComas, R.F. Wimmer-Schweingruber, T.H. Zurbuchen (Invited lecture)

15:40-16:00 **Understanding the Origin of Solar Energetic Particles (SEPs) with NASA's Sentinels Mission and ESA's Solar Orbiter Mission** **S1.5**
R. P. Lin (Invited lecture)

16:00-16:30 **Coffee Break**

16:30-16:45 **Interplanetary shocks and magnetic clouds from the inner heliosphere to 1 AU: From Wind and ACE to Solar Orbiter and Sentinels** **S1.6**
A. Szabo

16:45-17:00 **Turbulence in the solar wind – prospects for Solar Orbiter** **S1.7**
T. S. Horbury, M. A. Forman, S. Oughton

17:00-17:15 **Relevance of Supra-Thermal Ion Observations for Heliospheric Physics** **S1.8**
Livi, S. A., G. C. Ho, N. Paschalidis, M. I. Desai, F. Allegrini, and D. J. McComas

17:15-17:30 **Flare Generated Energetic Electrons Observed by the Solar Orbiter** **S1.9**
Gottfried Mann

17:30-17:45 **Solar wind electrons and associated heat conduction in the solar wind** **S1.10**
Chadi Salem, Stuart D. Bale, and Milan Maksimovic

17:45-18:00 **Neutral Solar Wind Numerical Simulations as Expected at the Solar Orbiter Position** **S1.11**
R. D'Amicis, S. Orsini, E. Antonucci, A.M. Di Lellis, M. Hilchenbach, D. Telloni, S. Fineschi, R. Bruno, A. Milillo, E. De Angelis

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18:00 **Adjourn**

19:00 **Social event : Welcoming cocktail at the National Observatory of Athens**

S1.1 Status of knowledge after Helios, Ulysses and SOHO of the microstate of the coronal and solar-wind plasma

Eckart Marsch
Max Planck Institute for Solar System Research, 37191 Katlenburg-Lindau, Germany

One main goal of Solar Orbiter is to determine the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere. In this review we will address the kinetic plasma physics of the solar wind, with emphasis on the present state of empirical knowledge and theoretical understanding. The in-situ measurements of solar-wind particles and plasma waves are reviewed, as well as the results obtained by remote-sensing of the solar corona by means of ultraviolet spectroscopy and imaging. To explain coronal and interplanetary heating, and generally transport phenomena, the dissipation at small scales of various forms of mechanical, electric and magnetic energy (contained in nonthermal particles, waves and turbulence) must be addressed. We discuss, besides the effects of Coulomb collisions, important kinetic processes such as wave-particle interactions through Landau or cyclotron-resonant absorption and emission of plasma waves and the related microinstabilities. Selected aspects (important virtues and severe limitations) of fluid models including magnetohydrodynamic turbulence and of kinetic models are critically discussed. Promising areas and future perspectives for research to be done with Solar Orbiter are identified.

S1.2 Determining the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere. Why and how?

Marco Velli
Jet Propulsion Laboratory, Cal. Tech./ University of Florence, Astronomy Dept.

The Solar Orbiter will provide the first opportunity of returning to the inner heliosphere after Helios, decreasing the previous closest perihelion to 0.21 AU, and coming on the shoulders of the success of not only Helios but also Ulysses, SOHO and many other investigations of the solar atmosphere and interplanetary medium. Here I will discuss some of the scientific questions detailed in the scientific requirements document as relevant to the first top-level scientific goal, grouped by their subject matter:

A) Evolution of "steady" coronal heating and solar wind acceleration.

i. What is the character and radial evolution of solar wind structures in the inner heliosphere?

ii. What is the nature of solar wind stream interactions in the inner heliosphere, and how does it depend on latitude?

iii. How does the solar wind microstate evolve with radial distance?

B) Micro and macro physics of solar activity.

i. What is the influence of CMEs on the structure of the inner heliosphere?

ii. What are the sources of solar energetic particles in the heliosphere, and what are the processes responsible for their acceleration?

iii. What are the fluxes and spectra of low-energy solar neutrons?

C) Exploring the inner heliosphere dust environment.

7. What are the sources and properties of dust in the inner heliosphere, and do Sun-grazing comets contribute to the dust?

S1.3 Solar Orbiter science and its requirements, observational strategies: energetic particles

Karl-Ludwig Klein
Observatoire de Paris, LESIA-CNRS UMR 8109, F-92195 Meudon

The Sun is a unique place where in situ measurements and remote sensing observations can be combined to gain insight into basic processes of energy conversion and particle acceleration of astrophysical interest. Solar energetic particle events are produced together with different forms of solar activity, including flares, CMEs and, in the case of low-energy electron beams, quiescent active regions. The acceleration processes remain a subject of debate, and the detailed comparison with electromagnetic signatures of energetic particles is an emerging subject. Although many believed in the 1990s and early 2000s that one could clearly distinguish flare-accelerated events and CME shock-accelerated events by their observational characteristics, the picture has become more complicated in recent years due to findings such as the energy-dependence of charge states, the association of coronal mass ejections and flares with all types of particle events, and the complex timing of particle arrivals at spacecraft with respect to electromagnetic signatures of energetic particles in the solar atmosphere.

Solar Orbiter provides a unique opportunity to further our understanding of the origin of energetic particle populations of solar origin: in situ measurements in the inner heliosphere will allow us to probe particle and wave populations around shocks, for which we rely for the time being on modelling and on the extrapolation of measurements made at 1 AU. Similarly, the time evolution of properties of solar energetic particle events will be probed in the inner heliosphere much closer to their sources, i.e. under conditions of minimum distortion due to propagation in interplanetary space. And finally, the phases of near corotation of the spacecraft with the Sun will allow us to see successive particle events from the same active region in comparable large-scale magnetic configurations, and therefore to better separate effects of the particle source from those of particle transport. This talk will illustrate the advantage of inner heliospheric observations, of which HELIOS observations gave a flavour, and will discuss the distinctive new apport due to the combination with remote sensing observations from Solar Orbiter and from ground.

S1.4 Properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere: Instrumental approaches to achieve the required measurements.

Christopher J. Owen[1], S.D. Bale[2], A.J. Coates[1], M.I. Desai[3], A.N. Fazakerley[1], T.S. Horbury[4], P. Louarn[5], M. Maksimovic[6], D.J. McComas[3], R.F. Wimmer-Schweingruber[7], T.H. Zurbuchen[8]

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[8] Department of Atmospheric, Oceanic and Space Sciences, University of Michigan, Ann Arbor, MI 48109, USA

Solar Orbiter will explore hitherto uncharted regions of the innermost heliosphere. In addition to powerful, high-resolution optical instruments, it will carry a suite of state-of-the-art instruments to sample, in situ, the properties, dynamics and interactions of plasma, fields and particles in the near-Sun heliosphere. Observations by this instrumentation will allow us to address fundamental questions concerning plasma processes at work in the solar atmosphere and heliosphere, and to determine the links between the magnetic field-dominated regime in the solar corona and the particle dominated regime in the heliosphere. For example, they will allow us to understand the characteristics of the solar wind and energetic particles in close linkage with the plasma conditions in their source regions on the Sun. In addition, the plasma and field instruments will have high temporal resolutions, and thus offer unique possibilities for resolving plasma kinetic processes at intrinsic scales. Therefore, Solar Orbiter will reveal new insights into the processes that structure the Sun's atmosphere, heat the inner corona and accelerate the solar wind and energetic particles.

In order to achieve the science goals, the solar wind in situ instrumentation will need to return high-cadence measurements of 3-D velocity distribution functions of electrons, protons, α-particles and abundant heavy ions such as O6+ and, if possible, a low iron charge states such as Fe9+ or Fe10+. Energetic particle measurements must cover the energy spectrum, angular distribution, and composition of energetic particles from the highest energies down to solar wind energies. In addition, reliable, high-time resolution determination of the heliospheric magnetic field vectors is essential, as are electric field and radio wave measurements which provide information on for example, of electron beams, local langmuir waves, wave-particle interactions and shock waves propagating from the corona as well as plasma turbulence. In this presentation we concentrate on the science goals related to the in situ exploration of the inner heliosphere and in particular we address the innovations in instrument designs that will be required to meet these goals in Solar Orbiters challenging measurement environment.

S1.5 Understanding the Origin of Solar Energetic Particles (SEPs) with NASA's Sentinels Mission and ESA's Solar Orbiter Mission

R. P. Lin and the Sentinels Team
Physics Dept & Space Sciences Lab, Univ. of California, Berkeley CA 94720-7450, USA

After decades of observations near 1AU, the physics of the solar/inner heliosphere processes that produce Solar Energetic Particles (SEP) events are still not understood.. Both the Inner Heliosphere Sentinels (IHS) and Solar Orbiter will utilize Venus gravity assists to achieve perihelions of ~0.22-0.25 AU, to minimize the effects of propagation and evolution, and thereby obtain in situ measurements of the freshly accelerated particles and of the relevant shock structure and upstream waves. Near perihelion, Solar Orbiter's orbit nearly co-rotates with the Sun so an active region can be continuously imaged and its SEP and solar wind plasma/field emissions measured to follow for weeks to follow its evolution. In addition, Solar Orbiter will provide measurements up to ~35 degrees out of the ecliptic. The four IHS spacecraft will provide the necessary multi-point in situ and remote sensing measurements to define the spatial variability of the acceleration process and the effects of suprathermal seed particles. In addition, the Near-Earth Sentinel (NES) will provide the physical conditions in the SEP acceleration region with a spectroscopic coronagraph and connect to the IHS measurements to imaging with a wide field (>~0.3 AU) coronagraph. Solar Orbiter, together with the Farside Sentinel (FS), will provide near global photospheric magnetic field measurements for accurate modeling the structure of the inner heliosphere. The combined measurements will lead to an understanding of SEP origin and improve our predictive capability for large SEP events.

S1.6 Interplanetary shocks and magnetic clouds from the inner heliosphere to 1 AU: From Wind and ACE to Solar Orbiter and Sentinels

A. Szabo and the NASA LWS Sentinels STDT Team
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Fast CMEs and their driven shocks are thought to be the primary sources of intense Solar Energetic Particle (SEP) events and are the main drivers of severe space weather at Earth. Therefore, one of the main objectives of the NASA LWS Sentinels program is to understand the characteristics, propagation and evolution of interplanetary CMEs and their associated shocks in the inner heliosphere. The specific related science questions raised by the recent Sentinels Science and Technology Definition Team (STDT) will be presented focusing on the initiation, global and internal characteristics and propagation of these heliospheric structures.

Currently active missions have very limited access to the inner heliosphere. However, near-Earth, 1 AU in situ observations place significant limits on shock and magnetic cloud properties. Recent, concurrent Wind and ACE observations of magnetic clouds and their driven shocks have established a close relationship between the orientations of the cloud axis and the local shock normals. These geometrical relationships will be discussed and their implications for necessary Sentinels and Solar Orbiter inner heliospheric in situ measurements.

S1.7 Turbulence in the solar wind – prospects for Solar Orbiter

T. S. Horbury[1], M. A. Forman[2], S. Oughton[3]
1 Imperial College London
2 SUNY, Stony Brook
3 U. Waikato, Hamilton

Turbulence pervades the solar wind, where it heats the plasma, scatters energetic particles and carries energy from the corona, as well as information about conditions there.

While slow solar wind appears to support a population of fully developed turbulence, that in fast wind is still evolving. By travelling close to the Sun, therefore, Solar Orbiter will let us sample solar wind turbulence in its least evolved state. This proximity will also make it easier to determine the solar origin of particular solar wind regions.

We discuss previous results regarding the form and evolution of solar wind turbulence, with an emphasis on our understanding of its evolution from Helios and Ulysses data. Many questions remain, including how coronal conditions determine the properties of the fluctuations and how turbulence is driven by stream shear: Solar Orbiter will help to solve these problems.

Using Helios data, we estimate the likely range of properties of the solar wind at 0.2 AU that are relevant for turbulence studies, such as the variation in solar wind speed, Alfvén Mach number and proton gyro-period, as well as the “breakpoint” scale of the transition from waves to turbulence.

We show that these are radically different to those at 1 AU, with important consequences for both instrument requirements (such as higher time resolution) and analysis techniques (since the wind will often have a significantly lower Mach number).

Anisotropy is a key property of plasma turbulence. We present recent results on the wavevector anisotropy of turbulence in high speed wind at several AU using a wavelet method and discuss how the same technique can be used with Solar Orbiter data to determine for this anisotropy changes as the turbulence evolves.

S1.8 Relevance of Supra-Thermal Ion Observations for Heliospheric Physics

Livi, S. A., G. C. Ho, N. Paschalidis, M. I. Desai, F. Allegrini, and D. J. McComas
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Particles that have energies of a few times the solar wind plasma energy up to 100s of keV/q are called suprathermal particles. Recent studies have revealed that these particles may significantly contribute as seed particles for acceleration either close to the Sun in solar energetic particle (SEP) events [Mewaldt et al., 2001], locally at 1 AU in energetic storm particle (ESP) events [Desai et al., 2003], and outside 1 AU as ions accelerated in Corotating Interaction Regions (CIRs) [Mason, 2000]. Thus, the interplanetary suprathermal ion population is believed to play a key role in various energization processes occurring near the Sun and throughout the heliosphere. However, the origin of these suprathermal particles is largely unknown at this time. Possible sources include: 1) suprathermal tails of the fast and slow speed solar wind; 2) interstellar and “inner source” pick-up ions; and 3) remnant material from both gradual and impulsive SEP events. This suprathermal ion reservoir is not a fixed quantity, but varys with time [Desai et al., 2006] and is also expected to vary in space. Moreover, the effects of the inherent variability of the suprathermal ion population on the accelerated ion populations are also completely unknown. It is therefore important to make high-time resolution composition measurements of this particle population in the inner heliosphere. Here we describe the type of challenging but critical measurements that are necessary to fully characterize key properties of the suprathermal energy regime that will ultimately enable us to better characterize its contributions to various particle acceleration processes occurring in the inner heliosphere.

S1.9 Flare Generated Energetic Electrons Observed by the Solar Orbiter

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Electrons are accelerated up to high energies during solar flares. A large fraction of the flare released energy is transferred into these electrons. Therefore, the understanding of the generation of energetic electrons at flares is a very important subject in high energy solar physics. Energetic electrons can be observed by their signatures in the nonthermal radio and X-ray radiation. If they become able to leave the corona along open magnetic field lines, they can be observed by in-situ measurements e.~g. by the WIND spacecraft. Several instruments aboard the Solar Orbiter will allow to get informations on the energetic electrons. They will be the Energetic Particle Detector (EPD), the Radio and Plasma Wave Analyzer (RPW), and the Spectrometer Telescope Imaging X-Ray (STIX). All the data recorded by these instruments will provide comprehensive information on the basic electron acceleration process during flares. That will demonstrated on special solar events previously observed by RHESSI and WIND, for instance.

S1.10 Solar wind electrons and associated heat conduction in the solar wind

Chadi Salem[1], Stuart D. Bale[1], and Milan Maksimovic[2]
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[2] LESIA, Observatoire de Paris-Meudon, Meudon, France.

The non equilibrium characteristics of the solar wind electron velocity distribution functions (eVDFs) at 1 AU are of great importance in many aspects, for instance in understanding heat conduction, plasma microinstabilities and transport in weakly collisional plasma, as well as in the scenario at the origin of the solar wind. It has been known for a long time that, in the ambient solar wind, eVDFs display a thermal core and a suprathermal halo populations present at all pitch angles, as well as a third antisunward magnetic field-aligned component called strahl; more recently a super-halo population has also been identified. Other recent works have emphasized the Lorentzian nature of eVDFs, i.e. the importance of their suprathermal tails, which is believed to play a crucial role in the exospheric expansion of the slow and fast solar wind. Based on either the usual core-halo or the Lorentzian (or Kappa) models of eVDFs, kinetic instabilities in space plasma have been discussed in the literature and wave growth rates have been calculated. However two fundamental questions are still subject to debate. They concern the physical nature and the origin of these non-thermal characteristics of the eVDFs. The associated problem of the electron heat conduction has also attracted space plasma physicists for a long time. Yet, the mechanisms that determine the electron energy transport and dissipation in the solar wind are far from being understood.

We present and review here results from recent investigations from both an observational (using Wind data at 1AU) and theoretical (using kinetic electron simulations) point of view, emphasizing the role of Coulomb collisions, and most importantly, of electron-whistler interactions in shaping the eVDFs in the corona and interplanetary space. We discuss how these results may impact the definition of both the science objectives and hardware design of the Solar Orbiter mission.

S1.11 Neutral Solar Wind Numerical Simulations as Expected at the Solar Orbiter Position

R. D'Amicis[1], S. Orsini[1], E. Antonucci[2], A.M. Di Lellis[3], M. Hilchenbach[4], D. Telloni[2], S. Fineschi[2], R. Bruno[1], A. Milillo[1], E. De Angelis[1]
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Neutral hydrogen is indicative of the behavior of the main solar wind component formed by protons out to at least 3 solar radii. In fact, beyond this distance the characteristic time for charge exchange between hydrogen atoms and protons becomes shorter than the coronal expansion time scale causing the neutrals to decouple from the charged solar wind. However they retain information on the three-dimensional coronal distribution of hydrogen at the distance where they are generated.

Considering the great importance of neutral solar wind (NSW) measurements to understand the evolution of the main solar wind component after decoupling from the neutrals, a NSW detector is at the moment one of the High Priority Augmentation instruments of the Solar Orbiter mission.

In the present study, we report our preliminary results concerning the simulation of the NSW distribution as expected at the Solar Orbiter position. We consider the evolution of a coronal-hole emerging solar wind whose major parameters are estimated by the SOHO UVCS experiment. The synergy between in-situ and remote sensing measurements will enable us to infer the degree of anisotropy, if any, in the neutral and charged coronal hydrogen close to 3 solar radii.

Tuesday 17 October 2006: Morning Session

S2 Investigate the links between the solar surface, corona and inner heliosphere

09:00-09:30 **Status of knowledge after Ulysses and SOHO** **S2.1**
Steven Suess (Invited lecture)

09:30-09:50 **Global Coronal Modeling in the Solar Orbiter Era** **S2.2**
Jon A. Linker, Zoran Mikic, Roberto Lionello, Pete Riley & Viacheslav Titov (Invited lecture)

09:50-10:10 **Charged Energetic Particles in the Innermost Part of the Heliosphere: Unsolved Problems** **S2.3**
David Lario (Invited lecture)

10:10-10:30 **How is Solar Orbiter going to achieve this goal - science and its requirements, Observational strategies: Remote-sensing and coronagraphy** **S2.4**
Silvano Fineschi (Invited lecture)

10:30-10:50 **Instrumental approaches to achieve the required measurements, In-situ particles** **S2.5**
Thomas H. Zurbuchen (Invited lecture)

10:50-11:10 **Instrumental approaches to achieve the required measurements, Remote-sensing and coronagraphy** **S2.6**
J. Daniel Moses (Invited lecture)

11:10-11.40 **Coffee Break**

11:40-12:00 **Synergistic Coronal & CME Studies During the Solar Orbiter Mission** **S2.7**
Angelos Vourlidas (Invited lecture)

12:00-12:15 **The Flux-Tube Texture of the Solar Wind: Is there Information about the Sun?** **S2.8**
Joe Borovsky *(presented by Bruce Barraclough)*

12:15-12:30 **The solar sources of two consecutive storms occurring in November 2004** **S2.9**
L. K. Harra, N. Crooker, S. Dasso, C. Mandrini, J. Wang, L. van Driel-Gesztelyi, H. Elliott, G. Attrill

12:30-12:45 **Viewing Structure in Coronal Images** **S2.10**
Huw Morgan

12:45-14:00 **Lunch Break**

S2.1 Status of knowledge after Ulysses and SOHO

Steven Suess
NASA Marshall Space Flight Center, Mail Code VP62, Huntsville, Alabama 35812,
steven.t.suess@nasa.gov

As spacecraft observations of the heliosphere have moved from exploration into studies of physical processes, we are learning about the linkages that exist between different parts of the system. The past fifteen years have led to new ideas for how the heliospheric magnetic field connects back to the Sun and to how that connection plays a role in the origin of the solar wind. A growing understanding these connections, in turn, has led to the ability to use composition, ionization state, the microscopic state of the in situ plasma, and energetic particles as tools to further analyze the linkages and the underlying physical processes. Many missions have contributed to these investigations of the heliosphere as an integrated system. Two of the most important are Ulysses and SOHO, because of the types of measurements they make, their specific orbits, and how they have worked to complement each other. I will review and summarize the status of knowledge about these linkages, with emphasis on results from the Ulysses and SOHO missions. Some of the topics will be the global heliosphere at sunspot maximum and minimum, the physics and morphology of coronal holes, the origin(s) of slow wind, SOHO-Ulysses quadrature observations, mysteries in the propagation of energetic particles, and the physics of eruptive events and their associated current sheets. These specific topics are selected because they point towards the investigations that will be carried out with Solar Orbiter (SO) and the opportunity will be used to illustrate how SO will uniquely contribute to our knowledge of the underlying physical processes.

S2.2 Global Coronal Modeling in the Solar Orbiter Era

Jon A. Linker, Zoran Mikic, Roberto Lionello, Pete Riley & Viacheslav Titov
Science Applications International Corporation, San Diego, CA, USA

Global MHD models of the corona and solar wind that use boundary conditions based on observed photospheric magnetic fields have now existed for more than a decade. Typically these models have avoided the complicated physics of the transition region by setting the ratio of specific heats gamma to a reduced value. These "polytropic" MHD models have been successful in describing a number of aspects of coronal and heliospheric data, including the location of coronal holes, the reproduction of streamer structure as seen in white light, and the location of the heliospheric current sheet. This approach also has fundamental limitations, for example density and temperature contrasts between open and closed field regions do not match observations, and the model does not address data from EUV and X-ray emission. Global models are now emerging that include energy transport (radiative losses, anisotropic thermal conduction, and coronal heating) in the transition region and solar corona and are capable of reproducing many emission properties as observed by spacecraft such as SOHO, Yohkoh, and TRACE. Such calculations have been performed in 1D loop models for years, but until recently obtaining solutions in 3D has been computationally intractable. The move towards petascale computing in the next few years will allow simulations of unprecedented resolution and physical detail. In this talk I will discuss how solar orbiter observations, coupled with these theoretical and computational advances, will allow us to tackle unsolved questions of coronal structure and dynamics.

S2.3 Charged Energetic Particles in the Innermost Part of the Heliosphere: Unsolved Problems

David Lario
The Johns Hopkins University. Applied Physics Laboratory

In situ observations in the innermost part of the heliosphere will provide us with decisive clues regarding the outstanding problems of solar energetic particle origin, acceleration and transport. Numerous observations at 1 AU have led to several scenarios for the origin of the seed particle populations that undergo the mechanisms of particle acceleration in the heliosphere. Modeling efforts have been developed to understand the processes of particle acceleration and transport throughout the heliosphere. Predictions made by these models, regarding mechanisms such as particle acceleration at shocks and amplification of turbulent magnetic field fluctuations modulating the energetic particle transport, can only be tested with observations taken much closer to the Sun. The Solar Orbiter mission specifically designed to go closer to the Sun (perihelion at ~0.2 AU) will provide us with the required observations to both verify these model predictions and answer many of the questions regarding the energetic particle environment of the innermost part of the heliosphere. Observations from the two Helios spacecraft (perihelion at 0.3 AU) allow us to infer the energetic particle environment that Solar Orbiter most likely will encounter during its nominal mission phase.

S2.4 How is Solar Orbiter going to achieve this goal - science and its requirements, Observational strategies: Remote-sensing and coronagraphy

Silvano Fineschi
INAF - Astronomical Observatory of Turin

Solar Orbiter will provide its onboard remote-sensing instrumentation with a unique - yet challenging - platform for investigating the links between the solar surface, corona and inner heliosphere.

Observational strategies will be discussed for connecting the sun-disk measurements of the high-resolution, limited field-of-view (FOV) telescopes with the wide-FOV coronagraphic observations.

Observation of the sun-disk from close distances (perihelion up to 50 solar radii) with 1-arcsec resolution telescopes will improve the spatial resolution by a factor 4 to 5 over that of the SOHO telescopes, at 1 A.U. The thermal load on the optics due to such close-up observations, though, will pose a technological challege. Observational strategies may be devised to cope with such a challenge, like for instance, a limitation of the telescope field-of-view (FOV) compensated by a spacecraft off-set pointing capability.

Remnants of solar surface features such as active regions, loops, prominences or sunspot are often found as variation of the distant solar wind in the corona. Studies of such structures are greatly complicated by the fact that their evolution occurs on time scales comparable to the solar rotation period. Solar Orbiter will provide a co-rotational vantage point that will allow to disentangle such effects. In order to link the changes of surface structures to variations of the solar wind, coronagraphic measurements will require wide-FOV observations. However, the ever changing distance of the spacecraft from the Sun will pose a challenge to the occulting capability of the coronagraph. Observational strategies will be discussed to deal with such a challenge, like for instance, using instrument off-set pointing or occulters with variable sizes.

S2.5 Instrumental approaches to achieve the required measurements, In-situ particles

Thomas H. Zurbuchen
University of Michigan

The Solar Orbiter mission will provide unprecedented opportunities to explore the inner heliosphere and its connection with the dynamic corona. The baseline instrument package described in the concept study is designed to take advantage of this unique opportunity. This presentation will first review the important properties of in situ particle measurement. It will then discuss the important synergies between instruments that will allow for breakthrough observations, if the instruments are run in a suite mode. Finally, it will address the role of synergies between the instruments and theoretical models which are expected to be crucial to achieve full science return.

S2.6 Solar Orbiter Instrumentation for Observation of Properties of Solar Structure Linking the Sun to the Heliosphere

J. D. Moses
Naval Research Lab, Solar Physics Dept.

Precedents from SOHO (LASCO, EIT, and UVCS) and STEREO (SECCHI) instruments make the design of instruments for Solar Orbiter a relatively straightforward matter.

The SOHO mission demonstrated the success of several key techniques for the observation of the solar corona and the inner heliosphere: the observation of the structure of the solar atmosphere in UV and EUV resonance lines with narrow band filters to establish morphology at characteristic temperatures, the combination of on-disk and off-disk spectroscopic observation in the UV and EUV to obtain plasma properties from the corona to the inner heliosphere, and the stepwise observation of light scattered from electrons and dust in the structures extending out from the base of the corona to the inner heliosphere with a series of coronagraphs. STEREO mission instruments for the determination of the origin, propagation and heliospheric consequences of CMEs were directly derived from the SOHO approach, with the major advance being the development of one additional coronagraphic instrument to extend the uninterrupted piecewise field of view from the solar corona to the Earth.

The unique Solar Orbiter requirements impose a somewhat greater effort to adapt the SOHO techniques than was needed for STEREO. The Solar Orbiter spacecraft mass and telemetry resource restrictions - as well as thermal environment - pose significant design challenges. To achieve full science return, the Solar Orbiter instrument must combine techniques from several predecessor instruments to measure the evolution of the density distribution and the relative abundance of the primary constituents of coronal structures as they merge into the heliosphere. A demonstration of specifically relevant instrument techniques (coronographic imaging in both the visible and UV) will be obtained with the launch during 2007 of a NASA/ASI/CNES Suborbital Program Payload (named "**He**lium **R**esonance **S**cattering in the **C**orona and **Hel**iosphere" in honor of solar astronomer John Herschel). The combination of SOHO, STEREO and HERSCHEL provide the basis for a high level of technological readiness to address the targeted Solar Orbiter science objectives.

S2.7 Synergistic Coronal & CME Studies During the Solar Orbiter Mission

Angelos Vourlidas
Naval Research Laboratory, USA

Solar Orbiter (SolO) is planned to start its science observations around the next solar minimum (2018-2020) and extend to the maximum of cycle 25. Given the demanding orbit and the restrictions on spacecraft resources, the mission will likely include a modest instrument payload. But SolO will not (hopefully) be the only solar mission at the time. The scientific return of the SolO mission will be greatly enhanced by joint observations with other instruments (in space and on Earth). In this talk, I will concentrate on the outer corona and coronal mass ejections and discuss the opportunities for synergistic science at the time of the SolO mission with an emphasis on the unique characteristics of the SolO orbit.

S2.8 The Flux-Tube Texture of the Solar Wind: Is there Information about the Sun?

Joe Borovsky
Los Alamos National Laborator, jborovsky@lanl.gov

The solar wind at 1 AU is full of discontinuities. These can be seen by sudden large changes in the magnetic-field direction, by sudden changes in the magnetic-field strength, by sudden changes in the plasma properties (density, ion temperature, electron temperature, ionic composition), by sudden large changes in the flow velocity, and by sudden changes in the hot-electron flux from the sun. These discontinuities are interpreted to be the walls of independently moving magnetic flux tubes (plasma tubes) with a spread of orientations about the Parker-spiral direction. This flux-tube texture of the plasma has strong implications for the flow properties of the solar wind: (a) much of the fluctuating flow of the solar wind is owed to relative motions of neighboring flux tubes and (b) often large-scale solar-wind flows break up along these flux tubes. The flux-tube texture also affects the properties of the MHD turbulence in the solar wind. Using measurements from ACE, the statistical properties of the flux tubes at 1 AU are examined, including their sizes, shapes, and orientations. Mapping the flux tubes back to the rotating sun, they are statistically compared with granule and supergranule structures on the solar surface. We explore the question of what solar-surface and solar-corona science can be done remotely by studying the detailed properties of the flux tubes in the solar-wind using measurements from 1 AU and from Solar-Orbiter distances.

(The talk will be presented by Bruce Barraclough)

S2.9 The solar sources of two consecutive storms occurring in November 2004

L. K. Harra, N. Crooker, S. Dasso, C. Mandrini, J. Wang, L. van Driel- Gesztelyi, H. Elliott, G. Attrill
UCL

For a full understanding of the Sun-Earth system it is vital to link remote sensing and in situ observations. In this paper we study 2 consecutive storms that occur during November 2004. The activity on the Sun during the period from 4th-8th November included solar flares, trans-equatorial coronal loop disappearances and reformation, and trans equatorial filament eruptions. These two storms reached the Earth with completely opposite magnetic field orientation despite the fact that the related flares were from the same active region.

We investigate the cause of these interplanetary CMEs (ICMEs), and describe how the evolution of the magnetic field progresses to create the two oppositely directed ICMEs.

S2.10 Viewing Structure in Coronal Images

Huw Morgan
Institute for Astronomy, University of Hawaii, 2680 Woodlawn Drive, Honolulu, HI 96822, USA

New image processing techniques, applied to white-light, *pB* or EUV observations, reveal the fine-scale detail of the corona whilst accurately depicting the large-scale structure. The images produced by the new techniques give new insights into the structure of streamers, are useful to unravel the complex topology of the solar maximum corona and can help make connections between coronal and solar disk features.

CMEs are seen in striking detail out to ~18 $R_\odot$. The quality of imaging produced by missions such as Solar Orbiter have a strong influence on the impact of that mission, and I show how the solar remote sensing instrumentation, in particular the EUV imager and coronagraph, can maximize their scientific and public outreach effectiveness by employing the new processing.

Tuesday 17 October 2006: Afternoon Session

S3	Explore, at all latitudes, the energetics, dynamics and fine-scale structure of the Sun's magnetized atmosphere	
14:00-14:30	**Status of Knowledge on Solar Fine-Scale Structure** Spiro K. Antiochos	**S3.1** (Invited lecture)
14:30-14:50	**How is Solar Orbiter going to achieve this Goal - Science and its requirements, Theoretical Aspects or rather, “the devil is in the detail”!** Robert W. Walsh	**S3.2** (Invited lecture)
14:50-15:10	**How is Solar Orbiter going to achieve this goal - science and its requirements, Observational strategies** Olav Kjeldseth-Moe	**S3.3** (Invited lecture)
15:10-15:40	**Instrumental approaches to achieve the measurements required for exploring the energetics, dynamics and fine-scale structure of the Sun's magnetized atmosphere** Udo Schühle	**S3.4** (Invited lecture)
15:40-16:00	**Synergies with other missions concerning ultraviolet imaging and spectroscopy** Hardi Peter	**S3.5** (Invited lecture)
16.00:16:30	**Coffee Break**	
16:30-16:45	**Nonlinear force-free coronal magnetic field modelling for SO/VIM** T. Wiegelmann, S. K. Solanki, A. Lagg, L. Yelles	**S3.6**
16:45-17:00	**Studying the magnetic origins of solar eruptions with Solar Orbiter** A. Nindos	**S3.7**
17:00-17:15	**Science with the Extreme Ultraviolet Spectrometer for Solar Orbiter** Peter Young	**S3.8**
17:15-17:30	**Impulsive Coronal Heating at Sub-arcsecond Scales: What is the Best Diagnostic?** S. Patsourakos & J.A. Klimchuk	**S3.9**
17:30-17:45	**Coronal turbulence and intermittency from Solar Orbiter observations** E. Buchlin and J.-C. Vial	**S3.10**
17:45-18:00	**Electron transport regimes and magnetic turbulence levels in coronal loops** G. Zimbardo, R. Martino, P. Veltri	**S3.11**
18:00	**Adjourn**	

S3.1 Status of Knowledge on Solar Fine-Scale Structure

Spiro K. Antiochos
Naval Research Laboratory

The high-resolution observations from the present set of solar missions, SOHO, TRACE and RHESSI, have greatly increased our knowledge and understanding of solar activity. From these observations it has become clear that fine-scale structure plays the critical role in both quasi-steady (coronal loop heating and solar wind acceleration) and explosive (coronal mass ejections and flares) phenomena. On the other hand, many key problems remain outstanding. For example, the mechanisms for coronal loop heating and CME triggering are still intensely debated. In this talk I will review the recent major advances in understanding solar activity from the viewpoint of the role of fine-scale structure, and discuss prospects for future advances.

S3.2 How is Solar Orbiter going to achieve this Goal - Science and its requirements, Theoretical Aspects or rather, "the devil is in the detail"!

Robert W. Walsh
Centre for Astrophysics, University of Central Lancashire, Preston, Lancashire, UK

One of the main goals of the Solar Orbiter mission is to examine the energetics, dynamics and fine scale structure of the magnetised atmosphere of the Sun. Thus, this short review talk will examine the theoretical consequences on the release, transport and dissipation of energy within this environment with the proposed Orbiter instrumental resolutions in mind. In particular, we will investigate the assumption (and possibly now the belief) that the loop-like structures that are observed with current instrumentation are actually composed of numerous, individual, finer plasma strands.

The impact of this multi-thread concept on (i) the existence and propagation of MHD waves (and consequently on coronal seismology) and (ii) the role of magnetic reconnection throughout the atmosphere (the ubiquitious nanoflare heating problem) will be outlined. Also, the important issue of balancing the competing spectral, spatial and temporal resolutions against the best possible science return as indicated from theoretical modelling will be discussed.

S3.3 Observational strategies for the study of fine scale structures of the Sun's magnetized atmosphere.

Olav Kjeldseth-Moe
University of Oslo, Institute of Theoretical Astrophysics

We review the properties of observed small-scale solar feature and their possible role in heating the solar atmosphere. Observational strategies that will improve our knowledge about these known features should include simultaneous and co-spatial observations of images, spectrograms and magnetic fields at sub arc second resolution. In addition we outline the need for observations aimed at detecting and studying possible hyper fine structures at high spectral resolution, since such features certainly hold the clue to a proper understanding of the solar atmosphere.

S3.4 Instrumental approaches to achieve the measurements required for exploring the energetics, dynamics and fine-scale structure of the Sun's magnetized atmosphere

Udo Schühle
Max-Planck-Institut für Sonnensystemforschung Max-Planck-Straße 2, D-37191 Katlenburg-Lindau

To explore at all latitudes the fine-scale structure and dynamics of the Sun’s magnetized atmosphere is one of the four main goals of Solar Orbiter and requires the combined observations of the solar instruments available on the mission. We will discuss the “science implementation” related to this specific scientific subject: the technical approaches to implement the observational scenarios outlined in the Science Requirements Document (SRD). Based on these requirements a strawman payload instrumental package has been built and specified in the Payload Definition Document (v.5). Specifically, a vector magnetograph (VIM), a EUV imager (EUI), a spectrograph (EUS) and a coronagraph (COR) are required to achieve the above goal and to investigate the links between the solar surface and the corona. The technical implementation of the instruments EUI and EUS will be shown in detail, and some of the viable design options will be compared and discussed in regard to the mission constraints. Compared to previous missions, for Solar Orbiter novel technical solutions are required to cope with, e. g., the higher heat input, higher radiation dose, lower telemetry rate, and more stringent cleanliness requirements. These lead to restrictions and possible compromises in the science performance which we shall exhibit.

S3.5 Synergies with other missions concerning ultraviolet imaging and spectroscopy

Hardi Peter
Kiepenheuer-Institut für Sonnenphysik, Schöneckstraße 6, 79104 Freiburg, peter@kis.uni-freiburg.de

The Solar Orbiter will provide a number of unique opportunities to observe the Sun from close-by, at co-rotation and from high latitudes not accessible for observatories in Earth orbit or at L1. Nevertheless other missions providing information in the EUV using imaging and spectroscopic instruments can provide valuable complementary information. In phases when the Orbiter observes parts of the Sun also accessible from other space observatories, the letter ones can provide data with a higher rate than the orbiter and through this allow a larger field of view and/or a faster time cadence. Also imagers could cover more wavelength bands and spectrometers might provide a larger spectral coverage and higher spectral resolution than possible on the Orbiter. The different profiles of the instrumentation on-board the Orbiter and other space observatories will answer different aspects on the physical problems tackled by future models and by this supply complementary information to better understand our Sun. This does also apply, even if the Orbiter and other mission will not be able to observe the same regions on the Sun during a large part of the mission.

S3.6 Nonlinear force-free coronal magnetic field modelling for SO/VIM

T. Wiegelmann, S. K. Solanki, A. Lagg, L. Yelles
Max-Planck-Institut fuer Sonnensystemforschung, Max-Planck-Strasse 2, 37191 Katlenburg-Lindau, Germany

The aim of this work is to investigate how photon noise and errors in the retrieval of solar magnetic parameters from measured Stokes profiles influences the extrapolation of nonlinear force-free coronal magnetic fields from photospheric vector magnetograms. To do so we use a nonlinear force-free extrapolation code based on an optimization principle. The extrapolation method has been extensively tested and applied to data from the VTT, SFT and IVM. Here we apply the code to artificial vector magnetograms obtained from 3-D radiation-MHD simulations. As a reference case we compute the coronal magnetic field from an ideal magnetogram and compare the result with more realistic magnetograms based on simulated Solar Orbiter/VIM-measurements. We investigate the effect of noise, ambiguities, spatial resolution, inversion mechanism of Stokes profiles etc. We rate the quality of the reconstructed coronal magnetic field qualitatively by magnetic field line plots and quantitatively by a number of comparision metrices, e.g., the vector correlation with the exact solution and how accurate the free magnetic energy is computed. We find that instrument effects and noise influence the quality of the nonlinear force-free coronal magnetic field model. The extrapolations from realistic vector magnetograms show a reasonable agreement with the ideal reconstruction, however, and are in particular significantly better than extrapolations based on line-of-sight magnetograms only. High quality VIM data will thus allow reasonably accurate extrapolations that can serve as the basis for magnetic coupling science through a comparison with observations from EUS and EUI.

S3.7 Studying the magnetic origins of solar eruptions with Solar Orbiter"

A. Nindos
Section of Astrogeophysics, Physics Department, University of Ioannina, Ioannina GR-45110, Greece

Recent studies have provided direct observational support for the paradigm that solar eruptions result from the interplay between magnetic reconnection and the approximate magnetic helicity conservation in the corona: flares without CMEs are regarded as reconnection events while CMEs are the valves through which the Sun gets rid of its excess helicity.

However, several aspects of the paradigm need clarification and possibly modification. The instruments onboard the "Solar Orbiter" mission will provide a unique opportunity for such work. In this talk, I propose a roadmap for the exploitation of the capabilities of the "Solar Orbiter" instruments in order to shed more light on the processes leading to eruptive events.

S3.8 Science With The Extreme Ultraviolet Spectrometer For Solar Orbiter

Peter Young and the EUS Science Working Group
CCLRC Rutherford Appleton Laboratory

The CCLRC Rutherford Appleton Laboratory (UK) is leading a consortium that proposes to build an ultraviolet spectrometer for Solar Orbiter provisionally called the Extreme Ultraviolet Spectrometer (EUS). In this presentation I will announce the wavelength bands chosen by the EUS Science Working Group, and describe the science that this choice allows. In particular I will state how the spectrometer will fit in with the Solar Orbiter science goals, and how it will interface with the other scientific instruments.

S3.9 Impulsive Coronal Heating at Sub-arcsecond Scales: What is the Best Diagnostic?

S. Patsourakos & J.A. Klimchuk
Naval Research Lab, Space Science Division, Washington, DC 20375,USA

Significant observational and theoretical evidence suggests that coronal heating operates at sub-arcsecond, currently unresolved, spatial scales and is impulsive in time. We will demonstrate that the most sensitive diagnostic for this type of heating is provided by spectroscopic observations in the early phase of such events.

We will demonstrate that the spectra of hot lines (> 5 MK) hold the signature of the impulsive heating process via the development of asymmetric or even double-component profiles. We will show how we plan to exploit this novel temperature window for probing coronal heating with observations of the EUV Imaging Spectrometer onboard the Solar-B mission.

Solar Orbiter (SOLO) will provide a unique opportunity to directly view the postulated sub-arcsecond impulsive energy releases. We will present synthetic SOLO spectroscopic observations of sub-arcsecond impulsive heating events and therefore assess its capabilities for probing this particular type of coronal heating.

Research supported by NASA and ONR.

S3.10 Coronal turbulence and intermittency from Solar Orbiter observations

E. Buchlin[1] and J.-C. Vial[2]
[1] Imperial College, London, Space and Atmospheric Physics
[2] Universite Paris-Sud/C.N.R.S., Institut d'Astrophysique Spatiale

Turbulent motions and magnetic fields are a key component of coronal heating mechanisms. They are indeed likely to produce the small scales at which the mechanisms such as reconnection are efficient enough. The properties of turbulence (and the associated intermittency) may thus have an influence on the energy dissipation in the corona, and need to be characterized from observations. Although turbulence is omnipresent from the Sun to the heliosphere, good observations of MHD turbulence have not yet been performed in the corona, in lines emitted at high temperature, where the heating actually occurs. We propose a study of coordinated EUS-EUI-VIM observations, with better resolution and counting statistics than ever before, whose main goal is to get and interpret the spatial statistics (spectra and structure functions) of the velocity field in lines emitted at high temperatures (log T >= 6.4), together with the plasma and magnetic environment of the observed region. These statistics will help us understand the precise role of coronal turbulence in the coronal heating processes.

S3.11 Electron transport regimes and magnetic turbulence levels in coronal loops

G. Zimbardo, R. Martino, P. Veltri
Dipartimento di Fisica, Universita' della Calabria, Cosenza, Italy

Recent observations by the TRACE spacecraft have shown that coronal emission in the extreme ultraviolet is characterized by filamentary structures within coronal loops, with transverse sizes close to the instrumental resolution [1]. Assuming that emission is due to hot electrons, the observations imply that electron transport along the magnetic field is much faster than electron transport perpendicular to it. Using the concepts of tangled magnetic fields and considering a transport regime in which both magnetic turbulence and collisions play a role, known as Rechester and Rosenbluth [2] diffusion, Galloway et al. [3] have recently derived estimates of the magnetic turbulence level. Knowing the value of the turbulence level is important in assessing the contribution to coronal heating of MHD wave dissipation. We elaborate on this idea, using up-to-date results on the transport of magnetic field lines in turbulent magnetic fields [4] and on the estimation of the Kolmogorov length [2,5]. Careful estimation of the relevant correlation lengths allows to obtain, when comparing with the observations, an estimate magnetic turbulence level of the order of $\delta B / B_0$ = 0.2, which is larger than the values proposed by Galloway et al. [3]. On the other hand, a more precise evaluation of the turbulence level and of the turbulence correlation lengths requires an improved spatial and temporal resolutions of ultraviolet observations. To this end, the ultraviolet coronograph of Solar Orbiter would be ideally suited. Indeed, beside the improved resolution, the corotating phase can be very important to obtain an accurate time sequence of images, which would show the intrinsic time evolution of the emitting filaments and would help in understanding the actual electron transport regimes.

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Wednesday 18 October 2006: Morning Session

S4	Probe the solar dynamo by observing the Sun's high-latitude field, flows and seismic waves	
09:00-09:30	**Review - Status of knowledge after SOHO and TRACE** Michael J. Thompson	**S4.1** (Invited lecture)
09:30-10:00	**How is Solar Orbiter going to achieve this goal - science and its requirements, Theoretical aspects** Karel Schrijver	**S4.2** (Invited lecture)
10:00-10:30	**Helioseismology: Science requirements and observational strategies** L. Gizon	**S4.3** (Invited lecture)
10:30-11:00	**Instrumental approaches to magnetic and velocity measurements in and out of the ecliptic plane** V. Martínez Pillet	**S4.4** (Invited lecture)
11:00-11.30	**Coffee Break**	
11:30-12:00	**Synergies with other missions and projects concerning visible-light observations** Wolfgang Schmidt	**S4.5** (Invited lecture)
12:00-12:15	**Local helioseismology at high latitudes** Irene Gonzalez-Hernandez	**S4.6**
12:15-12:30	**Solar coronal magneto-seismology with Solar Orbiter** R. Erdélyi and G. Verth	**S4.7**
12:30-12:45	**Observing the He II off-limb corona from Solar Orbiter** S. Giordano, S. Mancuso, L. Abbo, S. Fineschi	**S4.8**
12:45-13:00	**Disentangling the magnetic field structure of sunspots by synthetic polarization maps** D.A.N. Mueller, R. Schlichenmaier, C. Beck, G. Fritz	**S4.9**
13:00-14:00	**Lunch Break**	

14:00	**SOCIAL EVENT: Trip to Mycenae (archeological tour) and Nafplion followed by dinner at Nafplion (20:00).**	

S4.1 Review - Status of knowledge after SOHO and TRACE

Michael J. Thompson
University of Sheffield, U.K.

Helioseismology provides a unique tool for probing the solar dynamo by observing the evolution over the solar activity cycle of the solar interior. In particular we have now imaged the subphotospheric large-scale flows ("solar subsurface weather"), differential rotation and meridional circulation. We have also probed the stratification and flows under active regions and sunspots. I shall review the techniques and results, and consider both our current state of knowledge and future prospects.

S4.2 How is Solar Orbiter going to achieve its goals - science and its requirements

Karel Schrijver
Lockheed Martin Advanced Technology Center, Palo Alto, CA, USA.

The Sun's high-latitude magnetic field appears to be the product of the decay and advection of active regions emerging at lower latitudes and of the local emergence of small bipolar regions. This field shapes much of the heliospere during the majority of the solar cycle, and is deemed the seed field for subsequent global dynamo waves. Whereas the evolution of the high-latitude field seemed understood qualitatively, quantitative problems exist that point to couplings of field and flows that are poorly understood, to transport phenomena that appear to involve subsurface three-dimensional processes in addition to the approximation of surface transport mechaninisms, and to details of the high-latitude advective flows at the surface and in the interior that remain to be substantiated. In this review, I will address select of key problems that keep us from understanding the origin and evolution of the high-latitude field and its role as the basis of part of the heliosphere.

S4.3 Helioseismology: Science requirements and observational strategies

L. Gizon
Max Planck Institute for Solar System Research, 37191 Katlenburg-Lindau, Germany

Solar Orbiter will offer novel perspectives for helioseismology. The most interesting aspects of the mission reside in the unique vantage points from which the Sun will be viewed. Not only will out-of-the-Ecliptic observations enable us to reach higher heliographic latitudes into the solar convection zone, but Solar Orbiter in combination with Earth-side observations will also mean the advent of stereoscopic helioseismology. I shall discuss basic science requirements for helioseismology and, in particular, local helioseismology.

S4.4 Instrumental approaches to magnetic and velocity measurements in and out of the ecliptic plane

V. Martínez Pillet
Instituto de Astrofísica de Canarias

Crucial aspects of the solar dynamo, such as the cycle polarity reversal and the nature of the large scale flows near the polar region, need accurate velocity and magnetic field determinations. These two physical magnitudes are not directly accessible to any single photon-intensity measurement, but require two such measurements to be obtained and subtracted. It is this difference what can be calibrated in terms of line-of-sight velocity and/or magnetic flux. Such a `differential imager´ has stringent image stability needs as compared to normal imagers. In addition, these measurements require repeatable wavelength selection within a spectral line (thus bandpasses smaller than 100 mÅ) and polarization analysis that, through the Zeeman effect, provides the crucial magnetic information. For the Solar Orbiter mission, the magnetic measurements must provide accurate information to extrapolate the photospheric data to describe the local coronal field and provide the flux distribution and dynamics over the polar regions (that will be observed, at best, at a μ value of 0.57). The LOS velocity should be accurate enough to provide clear insights of the sub-photospheric flows prevailing at the latitudes accessible to the spacecraft. Very often this will be best done in coordination with a near Earth observing experiment.

This talk will address how such measurements can be achieved and what are the problematic areas one must carefully consider in the context of the Solar Orbiter mission.

S4.5 Synergies with other missions and projects concerning visible-light observations

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There are at least two distinct classes of visible light observations that are important to complement the Orbiter’s observations and to broaden the total scientific return of the mission: synoptic observations to provide context information, both in space and time and high-resolution measurements to complement the Orbiter’s remote sensing capabilities.

Visible light observations will mainly be carried out from ground-based stations. In order to guarantee good time coverage, networks of instruments distributed around the globe may eventually be needed. Besides imaging data of different layers of the solar atmosphere, from the deep photosphere to the chromosphere, visible light observations will also provide measurements of the magnetic field and the material flow field in different layers of the solar atmosphere.

Synoptic observations are needed to provide context data to the Orbiter’s high-resolution measurements. This will allow to embed the spectropolarimetric results in the context of the solar magnetic activity on larger spatial scales. Secondly, synoptic observations provide the temporal context that is needed to establish a connection between particle measurements and the underlying processes at the Sun’s surface.

The combination of simultaneous high-resolution spectropolarimetric measurements with the Orbiter and from ground will provide the unique opportunity to reliably measure the three-dimensional structure of both the magnetic and the velocity fields in the solar atmosphere.

S4.6 Local helioseismology at high latitudes

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Local helioseismology techniques such as ring-diagram analysis, time-distance and seismic holography have provided the scientific community with new and exciting results in the last couple of decades.

However, because of the characteristics of these techniques, they are limited in the latitude range where they can be applied without being seriously affected by projection and foreshortening effects of the solar data observed from the ecliptic perspective.

Here we show some preliminary results quantifying the improvement in large-scale flow dynamics research from ring-diagram analysis that would result from the analysis of solar orbiter/VIM data.

S4.7 Solar coronal magneto-seismology with Solar Orbiter

R. Erdélyi and G. Verth
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MHD waves in solar coronal loops, which were previously only predicted by theory have now actually been detected with instruments such as TRACE and SUMER on-board SOHO. These observations have given the solar community an important and novel tool to measure fundamental parameters in the magnetically embedded solar corona. Theory has been developed to derive detailed diagnostic information (density, magnetic field loop structure, geometry, stratification). However, all this exciting new theory can only be fully exploited if one has the instruments capable of measuring the theoretically predicted effects. It is crucial that the a spectrograph (EUS) and an imager (EUI) onboard Solar Orbiter are used together while observing an oscillating loop so that we can fully exploit this exciting new opportunity.

In the talk we demonstrate through examples of case studies specifically geared towards the observational spatial and time resolutions and capabilities of Solar Orbiter how the various cameras can be used for solar atmospheric (coronal) magnet-seismology.

Possible methods will be discussed to determine (i) if a magnetic field is constant or varying along a coronal loop by direct observation of fast kink standing mode oscillations; (ii) vertical gravitational scale height from observing the spatial distribution of loop oscillations; (iii) loop fine structure from observing the spatial intensity and velocity perturbations of the (two) lowest modes (possibly fundamental and first harmonic).

S4.8 Observing the He II off-limb corona from Solar Orbiter

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The Solar Orbiter represents a unique platform for off-limb solar corona observations, because of the near-Sun, helio-synchronous and out-of-ecliptic perspective. We discuss as the simultaneous monochromatic imaging of the hydrogen and helium solar coronae in addition to the visible light imaging allows to use the Doppler dimming diagnostics to derive velocity maps of the full corona and the maps of the abundance of helium relative to hydrogen. We compute the expected He II 303.78 A intensity with different assumptions on coronal model parameters, such as electron density, kinetic temperature and outflow velocity in the region from 1.2 to 4.0 solar radii.

The He II line is Doppler dimmed in presence of outflows, moreover we take into account the possibility of pumping effect due to nearby spectral lines. We evaluate the influence of the Si XI line at 303.32 A in the slow wind regions and we show that, in the case of very energetic events (e.g. very fast CMEs accompanied by strong flares) the Ca XVIII 302.19 A line pumps the He II and allows the estimate of coronal plasma speeds up to 1570 km/s. We study as the helium coronal diagnostics from the out-of-ecliptic and helio-synchronous observations can moreover address the understanding of the processes leading to the elemental composition of the coronal streamers and hole boundaries, as example to establish roles of gravitational settling and Coulomb drag.

S4.9 Disentangling the magnetic field structure of sunspots by synthetic polarization maps

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Sunspots exhibit complex, highly structured magnetic fields and flows. Disentangling the atmospheric structure of sunspots is a great challenge, and can only be achieved by the combination of spectropolarimetry at high spatial resolution and detailed modeling efforts.

We use a generalized 3D model that embeds magnetic flux tubes in a stratified atmosphere and calculates the emerging polarization of spectral lines for arbitrary viewing angles. The resulting polarization maps are a very efficient tool to distinguish between different atmospheric scenarios and determine the 3D structure of the magnetic field and the flow field.

In this contribution, we present the first synthetic maps of different polarization-related quantities, e.g. net circular polarization, total linear polarization and zero-crossing wavelength, for several spectral lines of interest. Among those are the Fe I 617.3 nm line which would be observed by the VIM instrument aboard Solar Orbiter and the well-studied Fe I 630.15/630.25 nm doublet which will be observed by Solar-B.

Thursday 19 October 2006: Morning Session

S5 Session 5: Poster Session

09:00-11:00	**POSTERS**
11:00-11:30	Coffee Break
11:30-13:00	**POSTERS**
13:00-14:00	Lunch Break

Thursday 19 October 2006: Afternoon Session

S6	Open session on science objectives and instrumental issues of Solar Orbiter	
14:00-14:15	**EUI, the ultraviolet imaging telescopes of Solar Orbiter** J.-F. Hochedez , T. Appourchaux, J.-M. Defise, L. K. Harra, U. Schuehle and the EUI Team	**S6.1**
14:15-14:30	**Simulations of science data of the SO-VIM instrument** Lotfi Yelles, Andreas Lagg, Johann Hirzberger, Joachim Woch, Sami K. Solanki, Alexander Vögler	**S6.2**
14:30-14:45	**X-ray Imaging and Spectroscopy with Solar Orbiter** Säm Krucker, Gordon H. Hurford, R.P. Lin	**S6.3**
14:45-15:00	**An Extreme UV Spectrometer for Solar Orbiter** Richard A. Harrison	**S6.4**
15:00-15:15	**The lower transition region as seen in the H I Lyman Alpha line** L. Teriaca, U. Schuehle, S.K. Solanki, W. Curdt, E. Marsch	**S6.5**
15:15-15:30	**Peering into the coronal holes: new results from old SUMER data** M. D. Popescu, D. Banerjee, J. G. Doyle	**S6.6**
15:30-15:45	**Neutral solar wind and the inner source of the pick-up ions** Andrzej Czechowski, Martin Hilchenbach	**S6.7**
15:45-16:15	**Coffee Break**	
16:15-16:30	**A Radio and Plasma Wave experiment for the Solar Orbiter mission** M. Maksimovic, S. D. Bale, A. Vaivads, V. Krassnoselskikh, T. Chust, M. Balikhin, K. Goetz, P. Gough, P. Travnicek, J. Soucek and H. Rucker	**S6.8**
16:30-16:45	**Antenna and instrument design considerations for electric field, plasma wave, and radio measurements on Solar Orbiter** S. D. Bale, M. Maksimovic, A. Vaivads, M. Andre, L. Blomberg	**S6.9**
16:45-17:00	**The Solar Wind Proton and Alpha Sensor for the Solar Orbiter** D. J. McComas, M. I. Desai, F. Allegrini, N. A. Schwadron, M. Berthomier, R. Bruno, and E. Marsch	**S6.10**
17:00-17:15	**A magnetometer for Solar Orbiter** C. M. Carr, T. S. Horbury, S. D. Bale, W. Baumjohann, B. Bavassano, D. Burgess, P. J. Cargill, N. Crooker, G. Erdos, et al.	**S6.11**
17:15-17:30	**Observing MHD turbulence around 0.2 AU** R. Bruno, R. D'Amicis, B. Bavassano, M.B. Cattaneo, V. Carbone and L. Sorriso-Valvo	**S6.12**
17:30-17:45	**The Energetic Particle Detector for Solar Orbiter** Robert F. Wimmer-Schweingruber, Bernd Heber, G. M. Mason, R. P. Lin, E. Valtonen, J. Ryan, J. Rodriguez-Pacheco	**S6.13**
17:45-18:00	**Jovian electron distribution in the inner heliosphere** B. Heber, O. Sternal, W. Dröge, R. Gómez-Herrero, A. Klassen, R. Müller-Mellin, R. Wimmer-Schweingruber, M.S. Potgieter	**S6.14**
18:00-18:30	**DISCUSSION** on science and payload optimization	
18:30	**Adjourn**	

S6.1 EUI, the ultraviolet imaging telescopes of Solar Orbiter

J.-F. Hochedez[1], T. Appourchaux[2], J.-M. Defise[3], L. K. Harra[4], U. Schuehle[5] and the EUI Team

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The scientific objectives of Solar Orbiter rely ubiquitously on EUI, its suite of solar atmosphere imaging telescopes. It takes advantage of three of the original mission characteristics: the orbital phases of co-rotation, solar proximity and departure from the ecliptic. The design presented here offers dependable solutions, which assimilate the trade-offs between availability of resources and technical challenges of the S.O. mission, on one hand, and achieving performance goals such as spatial resolution and high image cadence on the other.

EUI includes three co-aligned High Resolution Imagers (HRI) and one Full Sun Imager (FSI). Using multi-layer coatings and metallic filters, the FSI and two of the three HRIs observe in extreme UV passbands, dominated by coronal emission. Furthermore, one HRI is designed to select Hydrogen Lyman-alpha radiation in the far UV, imaging the chromosphere and lower transition region. Thus, in synergy with the other S.O. payload, EUI will: probe the dynamics of the solar atmosphere; provide context data for all investigations and help to link in-situ and remote-sensing observations. In short, it serves all four top-level goals of the mission: it will for example describe the boundary conditions of the near-Sun heliosphere; it will reveal the evolution of regions responsible for SEPs and of those corresponding to the source of the fast or slow solar winds; the HRIs will capture the fine-scale dynamics - and hence heating mechanisms - of coronal features; and during certain epochs, FSI will observe globally the "far-side" or the poles.

For these reasons, the EUI suite is keenly anticipated in the European scientific community and beyond. Through open meetings and information policy our EUI consortium encourages and anticipates broad and active collaborations with the scientific community to successfully optimize its science exploitation.

S6.2 Simulations of science data of the SO-VIM instrument

Lotfi Yelles, Andreas Lagg, Johann Hirzberger, Joachim Woch, Sami K. Solanki, Alexander Vögler

The SO-VIM instrument will represent a two-dimensional full-Stokes spectro-polarimeter which will provide diffraction-limited vector-magnetograms, Dopplergrams, and continuum images of the solar photosphere. The instrumental performance depends on various parameters such as -- among others -- aperture diameter, filter characteristics, spectral-line sampling, and orbital position. Here we compute Stokes profiles in realistic 3D MHD simulations. These synthetic data are then degraded to match the output expected from the VIM instrument, and subsequently inverted using a Milne-Eddington atmosphere. We present parameter studies in order to set up minimum requirements and limitations of VIM's capabilities.

S6.3 X-ray Imaging and Spectroscopy with Solar Orbiter

Säm Krucker, Gordon H. Hurford, R.P. Lin
Space Sciences Lab, UC Berkeley

Solar flares are the most powerful explosions in our solar system, releasing up to 1e32-1e33 ergs in ~10-1000 s. The flare-accelerated ~20-100 keV electrons appear to contain a significant fraction, ~10-50 %, of this energy, indicating that the particle acceleration and energy release processes are intimately linked.

X-ray observations are excellent diagnostics of energetic electrons (> few keV) and hot (>1 MK) thermal plamas providing quantitative measurements such as total energy in energetic electrons.

This presentation will briefly summarize an instrumental concept for the HXR telescope onboard Solar Orbiter and will discuss scientific questions that can be answered including a discussion on coordinated in-situ/remote-sensing observations.

S6.4 An Extreme UV Spectrometer for Solar Orbiter

Richard A. Harrison and the EUS consortium
Rutherford Appleton Laboratory, UK

We present plans for an extreme-UV spectrometer (EUS) for Solar Orbiter, which is designed as a next-generation instrument to the SOHO-CDS and Solar-B EIS instruments but utilising technologies to cater for the requirements on low-mass, the extreme thermal and particle environments and autonomy during the encounter periods. A 1 metre class instrument is presented which consists of an off-axis normal-incidence system feeding a spectrometer with a variable line spaced grating and an Active Pixel Sensor (APS) detector system. The design allows < 1 arcsec pixel sizes (150 km on the Sun at perihelion) with instrument efficiencies substantially better than currently available, leading to a highly flexible tool for plasma diagnostic analyses of the solar atmosphere. The APS detectors are chosen to cater for the particle environment, and the thermal extremes are catered for through the use of a heat-stop prior to the spectrometer slit, which is designed to reflect much of the energy out through the instrument aperture, as well as dedicated radiators for the primary telescope and the detector system. A consortium has formed from a number of European and US groups to propose this instrument and has met on a number of occasions since 2001. Strategies for issues such as line selection and instrument operation, as well as optimisation of the optical and thermal design will be discussed.

S6.5 The lower transision region as seen in the H I Lyman Alpha line.

L. Teriaca, U. Schuehle, S.K. Solanki, W. Curdt, E. Marsch
Max Planck Institute for Solar System Research

The SUMER spectrometer aboard SOHO has been used to acquire several raster images and temporal series of quiet-Sun targets at both disk centre and the limb. Spectra have been recorded simultaneously in the H I Lyman Alpha and the Si III 120.6 nm line. Both spatial and temporal maps of the integrated radiances appear very similar in the two lines, despite the huge difference in optical thickness, showing the H I Lyman Alpha to be a good diagnostic of the dynamics and morphology of the lower transition region.

Oscillations can be detected and studied at all observed locations. At disk centre, the 3 min. oscillations are sporadically observed in the internetwork but also at locations at the edges of network lanes, while 5 min. oscillations clearly dominate the network. At the limb, evidence of 3 to 5 min oscillations is found at the base of spicules. The latter and the larger macrospicules are also observed and studied. Moreover, the H I Lyman Alpha spectral profiles show a high degree of variability, revealing also the signature of transition region explosive events. The combination of high spectral purity images and slit spectra in the H I Lyman Alpha line would therefore provide an exceptional tool to investigate the nature of the solar transition region. This line is therefore of interest for both, a high resolution channel in the EUI instrument and for EUS.

S6.6 Peering into the coronal holes: new results from old SUMER data

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One of the goals of the Solar Orbiter mission is to study at unprecedented detail the regions of the Sun which cannot be accessible from around the Earth: polar coronal holes. Despite looking dark and quiet, polar coronal holes may hold the key in answering many important questions about the Sun's inner -- as well as extended -- atmosphere, as they are the sites from where the fast solar wind originate.

When planning new missions it is important to have a full understanding of previous data. But, for phenomena with scales often less than the available resolution, it is not easy to characterize them well.

We have found new results about the small-scale structures of coronal holes and their consequence on explaining the nature of the fast solar wind. The results have been derived due to an innovative way of extracting information from the spectral data offered by the highest resolution solar spectrograph to date, SUMER on SoHO.

We therefore present evidence that outgoing jets of plasma, which may have an important contribution to the fast solar wind outflow, originate from above explosive event sites. These jets have a lifetime of about 5 minutes and are often seen reoccurring at the same location over intervals of around 30 minutes. They typically have velocities of the order of 50-200 km per second, e.g. the shape of the line is a double Gaussian seen not only in the transition region N IV line but, for the more energetic events, also in the hot Ne VIII line, believed to be formed at the base of the corona in coronal holes.

Although the expelled jets might actually extend high in the Sun's atmosphere, they are not seen in the intensity on the disk. Some of the transparent features might nevertheless appear as macro-spicules at the Sun's edge. This observation itself is sheding new light onto another long-standing question regarding the nature of macro-spicules, and may very well constitute the proof that some spicules (e.g. the macro-spicules) might be caused by reconnection, while, as shown by Hansteen et al. (2006, ApJ 647, L73), the other spicules are low-velocity (around 20 km per second) jets caused by chromospheric shocks driven by oscillations in the photosphere.

S6.7 Neutral solar wind and the inner source of the pick-up ions.

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For different models of the solar wind near the Sun including the neutral component, we estimate the effect on the solar wind proton distribution function caused by the interaction with neutral hydrogen. We point out that the observations of the neutral solar wind provide a check on the amount of charge exchange occurring upstream from the observer. This check is of particular importance for the case of inner source pick up protons. We note that the present neutral solar wind data are consistent with the inner source proton flux.

S6.8 A Radio and Plasma Wave experiment for the Solar Orbiter mission

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As part of the baseline Solar Orbiter payload the Radio and Plasma Wave (RPW) experiment will provide measurements of both electrostatic and electromagnetic waves in a broad frequency band (typically from a fraction of a Hertz up to a few tens of MHz) covering characteristic frequencies in the solar corona and interplanetary medium. RPW will provide in-situ measurements in the vicinity of the spacecraft and extensive remote-sensing of energetic phenomena in the heliosphere.

We present the general characteristics of a RPW experiment that we wish to submit in response to a possible Announcement of Opportunity for the Solar Orbiter payload. This proposal comprises two main sub-systems: a Low Frequency Receiver (LFR) and waveform unit covering in-situ measurements and a Thermal Noise and High Frequency receiver (TNR/HF) for remote-sensing and electron measurements at the local plasma frequency.

The two sub-systems will be connected to two different sensor units: an electric antenna unit and a magnetic search coils unit that will be both optimized to perform correctly both DC and high frequency measurements. The two sub-systems will have a common digital signal processing that should also allow particle/wave correlations.

S6.9 Antenna and instrument design considerations for electric field, plasma wave, and radio measurements on Solar Orbiter

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Electric fields in the solar wind are very poorly studied; there have been no instruments dedicated to measuring solar wind electric fields and plasma waves at low frequencies. Here we discuss some of the important physics of LF electric fields, including dissipation of MHD turbulence, shock acceleration of particles, and solar wind magnetic reconnection. We then present some antenna sensor and instrument designs that will potentially satisfy the goal of measuring both DC/low frequency electric fields AND higher frequency radio and thermal noise emissions. We discuss trades between science goals and complexity of the designs.

S6.10 The Solar Wind Proton and Alpha Sensor for the Solar Orbiter

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The Solar Orbiter mission is designed to make unique measurements of hitherto unexplored regions near the Sun with the aid of a comprehensive suite of in-situ and remote sensing instruments that will lead to crucial breakthroughs in the areas of solar and heliospheric research. The Solar Wind Plasma Analyser (SWA) consists of three separate sensors to enable complete characterization of the kinetic and fluid properties of solar wind and suprathermal ions and electrons, and measurement of the ionic, isotopic, and elemental composition of all the major solar wind species. The primary scientific objective of the Solar Wind – Proton and Alpha Sensor (SW-PAS) is to provide observational constraints on kinetic and fluid properties of the bulk solar wind plasma that will ultimately lead to new discoveries and improved understanding of coronal heating, the origin and acceleration of the solar wind, and the seed population of solar proton events. Specifically, the SW-PAS will provide 3D velocity distribution functions of solar wind and suprathermal protons and alpha particles at high temporal resolution. The PAS sensor uses three electrostatic lenses in combination with a micro-channel plate detector to separate and analyze protons and alpha particles between 200 eV/q–20 keV/q. In this paper, we outline the main scientific goals, the instrument concept, and the critical issues that will be considered in the design and development of the SW-PAS sensor.

S6.11 A magnetometer for Solar Orbiter

C. M. Carr, T. S. Horbury, S. D. Bale, W. Baumjohann, B. Bavassano, D. Burgess, P. J. Cargill, N. Crooker, G. Erdos, L. Fletcher, R. J. Forsyth, J. Giacalone, K.-H. Glassmeier, T. Hoeksema, M. L. Goldstein, V. Nakariakov, M. Lockwood, M. Maksimovic, E. Marsch, W. H. Matthaeus, N. Murphy, P. Riley, C. T. Russell, S. J. Schwartz, A. Szabo, M. Thompson, R. Vainio, M. Velli, R. Walsh, R. Wimmer-Schweingruber, G. Zank

The magnetic field is a fundamental property of any plasma and the precise measurement of the local field is key to many aspects of Solar Orbiter science. The magnetic field is the link between the Sun and the heliosphere. One science goal of the magnetometer investigation, therefore, is the measurement of how the Sun's magnetic field extends into interplanetary space and hence how different types of solar wind originate in different regions of the corona. Kinetic effects such as wave-particle interactions, plasma heating and the acceleration and propagation of energetic particles will also be studied. In addition, the magnetic field will be vital in determining the form and evolution of coronal mass ejections and other discrete structures.

The science team has extensive theoretical, modelling and data analysis experience and includes experts from all aspects of science which are relevant to the magnetometer, such as the solar dynamo; coronal heating and dynamics; solar wind acceleration; waves and turbulence; and energetic particles.

The team, led by Imperial College London, includes the 5 leading institutions world-wide which design, build and operate deep-space magnetometers, with unrivalled experience and expertise. We present the baseline instrument design, with twin fluxgate sensors, and discuss its capabilities.

Many of the most important scientific advances of the mission will be made by linking together data from several instruments, both within the in situ payload and between the remote sensing and in situ instruments. It is vital, therefore, that planning, operations and analysis are coordinated between these instruments; we discuss potential methods of achieving this coordination, including direct instrumental links on the spacecraft.

The accurate measurement of the interplanetary magnetic field places requirements on both the instrument and the mission as a whole: we discuss these and how they can be met through hardware and software, particularly with respect to magnetic cleanliness of the spacecraft and other instruments.

S6.12 Observing MHD turbulence around 0.2 AU

R. Bruno[1], R. D'Amicis[1], B. Bavassano[1], M.B. Cattaneo[1], V. Carbone[2] and L. Sorriso-Valvo[2]

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Recent results obtained from the analysis of interplanetary observations recorded by Helios 2 within the inner heliosphere showed, for the first time, that the Probability Distribution Function (PDF) of magnetic field vector fluctuations, within the MHD frequency range of turbulence, can be remarkably well fitted by a double log-normal. These two components of the total PDF have been ascribed to Alfvénic fluctuations and advected structures. Since this analysis was carried on using only magnetic field data because of low time resolution of plasma measurements, we lack of a sure proof of the Alfvénic nature of those fluctuations that we believe contribute to one of the two lognormals. Moreover, we still don't know whether the advected structures forming the second lognormal are locally generated by the turbulent evolution of the fluctuations or they rather come from the source regions of the wind where they reflect the complicate topology of the magnetic field. Remote sensing and high time resolution in-situ observations performed by Solar Orbiter at the perihelion, during the corotation phase, would certainly amplify the results already reached by Helios and would eventually give an answer to these problems.

S6.13 The Energetic Particle Detector for Solar Orbiter

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The Energetic Particle Detector (EPD) suite of instruments for Solar Orbiter consists of a suprathermal electron sensor (STE), a suprathermal ion spectrometer (SIS), an electron proton telescope (EPT), a low energy telescope (LET), and high energy telescope (HET), and a neutron gamma detector (NGD). With Solar Orbiter's unique orbit, EPD will open new windows on energetic phenomena on the Sun and particle acceleration in the inner heliosphere as well as the magnetic connectivity back to the Sun. We will discuss the scientific rationale for the EPD sensors and give brief instrument summaries.

S6.14 Jovian electron distribution in the inner heliosphere

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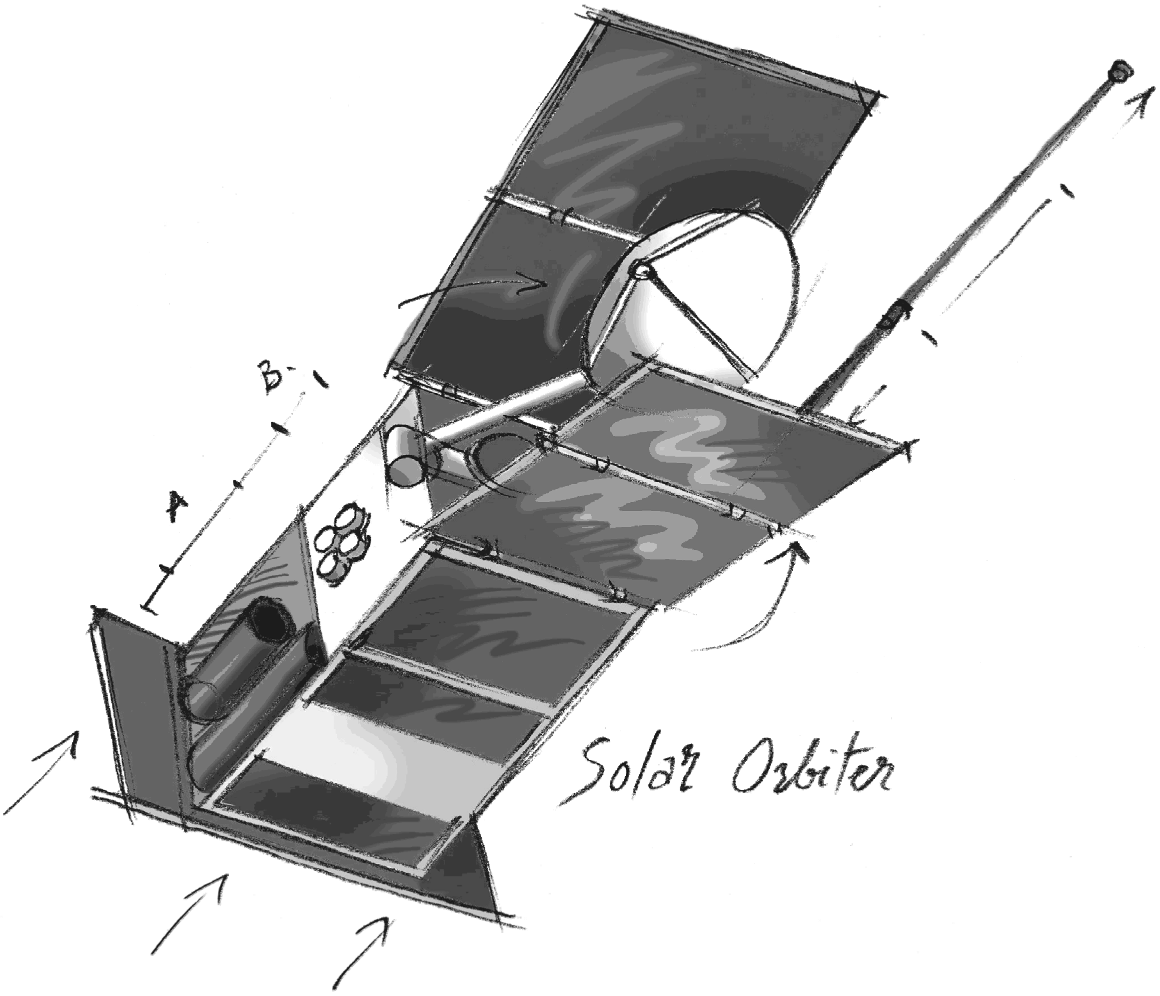
One of the fundamental problem in modern astrophysics is the propagation of cosmic rays in turbulent magnetic fields, which can be studied by way of in-situ measurements of energetic particles in the heliosphere. At 1 AU Jovian and galactic particles contribute continuously to the few-MeV electron intensities. As a result of this a 13 month period in the MeV electron intensity time profiles is observed at Earth. At solar maximum Jovian electrons could unambiguously be identified at all heliographic latitudes and ~10 AU away from the planet. In this contribution we will present Ulysses KET and SOHO EPHIN electron measurements. These observations are used to estimate the flux of Jovian electrons along the Solar Orbiter trajectory.


A
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Solar Orbiter

Friday 20 October 2006: Morning Session

S7	Payload optimization and design aspects	
09:00-09:15	**Implementing the thermal noise spectroscopy on Solar Orbiter** I. Zouganelis, M. Maksimovic, N. Meyer-Vernet, K. Issautier, M. Moncuquet	S7.1
09:15-09:30	**FNIT: A telescope for imaging solar neutrons below 10 MeV in the inner heliosphere** M.R. Moser, J.M. Ryan, U. Bravar, J.J. Connell, E.O. Flückiger, A.L. MacKinnon, J.R. Macri, M.L. McConnell, R.B. McKibben	S7.2
09:30-09:45	**Solar Orbiter Neutral Particle Detector** M. Hilchenbach, S. Orsini, K,C. Hsieh, E. Antonucci, S. Barabash, K. Bamert, R. Bruno, M.R. Collier, A. Czechowski, I. Dandouras, R. Esser, J. Giacalone, M. Gruntman, S. R. Habbal, J. R. Jokipii, E. Kallio, J. Kota, H. Kucharek, S. Livi, I. Mann, E. Marsch, E. Möbius, R. B. Sheldon, W. Schmidt, K. Szego, J. Woch, P. Wurz and T. H. Zurbuchen	S7.3
09:45-10:00	**Sputtering of Small Dust Particles and Charge Exchange of Solar Wind Ions** Peter Bochsler, Eberhard Möbius, and Robert F. Wimmer-Schweingruber	S7.4
10:00-10:15	**Optical Design of the Extreme Ultraviolet Spectrometer on board Solar Orbiter** Luca Poletto, Vania Da Deppo, Roger J. Thomas, Kevin Middleton	S7.5
10:15-10:30	**First steps to VIM: from simulations to IMaX observations** D. Orozco Suárez, L.R. Bellot Rubio, J.C. del Toro Iniesta	S7.6
10.30-10:45	**Why ESA should put a UV/EUV polarimeter in a solar space telescope?** Javier Trujillo Bueno	S7.7
10:45-11.15	Coffee Break	
11:15-12.30	**General discussion** R. Marsden	
12:30-13:00	**Closing address: summary and conclusions of the meeting** A. Gabriel	S7.8
13.00	END OF WORKSHOP	

S7.1 Implementing the thermal noise spectroscopy on Solar Orbiter

I. Zouganelis [1], M. Maksimovic [2], N. Meyer-Vernet [2], K. Issautier [2], M. Moncuquet [2]
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The measurement of the solar wind electron temperature in the unexplored region between 1 and 45 Rs is of prime importance for understanding the solar wind acceleration. Solar Orbiter's location, combined with the fact that the spacecraft will nearly co-rotate with the Sun on some portions of its orbit, will furnish observations placing constraints on solar wind models. We discuss the implementation of the plasma thermal noise analysis for the Solar Orbiter mission.

The thermal noise spectroscopy is based on a passive measurement of the plasma wave spectrum with a long electric antenna, and yields directly the density and the kinetic temperature of a stable electron velocity distribution. This method is a powerful tool to measure in situ the electron thermodynamic quantities in natural plasmas, and has been used in the solar wind, planetary ionospheres and plasmaspheres and cometary tails. In the context of the Solar Orbiter mission, the thermal noise will allow to get accurate measurements of the total electron density and electron temperature and to correct the spacecraft charging effects which affect the electron analyzers.

S7.2 FNIT: A telescope for imaging solar neutrons below 10 MeV in the inner heliosphere

M.R. Moser [1], J.M. Ryan [2], U. Bravar [2], J.J. Connell [2], E.O. Flückiger [1], A.L. MacKinnon [3], J.R. Macri [2], M.L. McConnell [2], R.B. McKibben [2]
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Probing of the Sun at small heliocentric distances can be conducted with the proposed Solar Orbiter spacecraft and mission. The flux and energy distribution of low-energy neutrons that arise in flares from nuclear reactions is of particular interest. Solar neutrons below 10 MeV suffer significant decay losses before reaching 1 AU. For heliocentric radii as close as 0.3 AU, the number of surviving neutrons from a solar event is dramatically greater. Measurements of neutrons in the energy range 1-10 MeV provide a new indicator of heavy ion interactions at low energies, where the vast majority of particles are. An instrument to make these measurements must be compact, lightweight, and efficient. We discuss instrument concepts for making these measurements, including use of neutron imaging techniques to increase the sensitivity and to optimize the signal-to-noise ratio.

S7.3 Solar Orbiter Neutral Particle Detector

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Neutral hydrogen atoms are closely coupled to the emerging solar wind plasma and give rise to the prominent solar Ly-alpha corona. The ratio of the densities of neutral hydrogen and protons is very small, some parts per million, and the neutral atoms are therefore a trace particle population in the solar wind plasma. In-situ observations of the neutral atoms, their flight paths (imaging), densities and velocity distributions are a new tool to the understanding of the Ly-alpha corona, i.e. setting limits on the plasma velocity distribution along the solar magnetic field lines. The second purpose of the neutral particle solar wind instrument are in-situ measurents in the potential source region of the inner pick-up ion population and the solar wind plasma - interplanetary dust grain interactions in the vicinity of the sun. We will discuss the gain and limitations of both observational goals and the potential "zero charge" solar wind instrumentation onboard Solar Orbiter.

S7.4 Sputtering of Small Dust Particles and Charge Exchange of Solar Wind Ions

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The origin of inner-source pickup ions is generally attributed to the interaction of solar wind ions with dust particles in the inner heliosphere. Charge states and elemental abundances of weakly ionized species in the solar wind can provide valuable information on the properties of dust in the innermost solar system. Sputtering of sub-micron sized grains by solar wind and suprathermal solar ions plays an important role in shaping the grain size distribution in the corona. The velocity distribution of inner-source ions reveals details on their production mechanisms. We investigate reasons for the apparent overabundance of neon compared to solar wind abundances in inner-source pickup ions. A plasma instrument capable of measuring charge state distributions and elemental abundances, as well as velocity distributions of weakly ionized species combined with a dedicated dust experiment promises exciting new results from Solar Orbiter.

S7.5 Optical Design of the Extreme Ultraviolet Spectrometer on board Solar Orbiter

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We present optical designs for the Extreme Ultraviolet imaging Spectrometer (EUS) proposed for Solar Orbiter. The instrument comprises a telescope which images the solar disk onto a slit, and a spectrometer which relays and disperses the slit image onto several detectors. For the telescope two designs are discussed: a single mirror normal incidence off-axis parabola, and a two mirror grazing incidence Wolter type telescope. The spectrometer, whose design is essentially independent of the choice of telescope, incorporates a Torroidal Variable Line Space (TVLS) grating, allowing high quality imaging at relatively large spectrometer magnifications, permitting a compact design.

The optical performance of the individual components and the instrument as a whole is presented and potential performance trade-offs are discussed.

S7.6 First steps to VIM: from simulations to IMaX observations

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In many respects, the Visible-light Imager and Magnetograph (VIM), aboard the ESA mission Solar Orbiter, builds upon the experience on the Imaging Magnetograph eXperiment (IMaX), aboard the stratospheric balloon mission Sunrise. The current concept for VIM is basically that for IMaX (with one single camera and probably two etalons) plus two telescopes. Hence, most of the work carried out for IMaX can have an application to VIM. This contribution is aimed at discussing on the many calculations we have been carrying out to simulate the real IMaX behavior. Numerical magnetohydrodynamical simulations by the MPS group are used to synthesize "observed" Stokes profiles of the photospheric, Fe I line at 525.6 nm at a spatial resolution of 150 km. We have analyzed the influence that, for instance, the image degradation due to photon noise and telescope diffraction, the instrumental profile width, or the noise, have on the determination of the magnetic field vector and line-of-sight velocity. We also analyze the performance of different methods of analysis. The Fe I line at 617.3 nm, the best candidate with VIM, is also analyzed.

S7.7 Why ESA should put a UV/EUV polarimeter in a solar space telescope?

Javier Trujillo Bueno
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The aim of this contribution is to discuss some of the key scientific arguments that indicate why a development like a UV/EUV polarimeter in space would have a great discovery potential in solar physics. We show that scattering polarization signals are to be expected not only at spectral line wavelengths at which the solar disk is seen bright, such as that of the Lyman α line of hydrogen, but also at EUV wavelengths for which the solar disk is seen dark. This theoretical prediction enhances further the scientific case for spectropolarimetry from space, because it offers new opportunities for inferring the magnetic field vector of coronal plasma structures via the Hanle effect.

S7.8 Closing address: summary and conclusions of the meeting

Alan Gabriel
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We review the ideas presented at this Workshop and try to draw conclusions in the light of the discussions which take place.

Posters

P.01 How far is the dissipative range in the solar wind turbulence?

O. Alexandrova, V. Carbone, L. Sorriso-Valvo and P. Veltri

Magnetic fluctuations in the solar wind follow nearly Kolmogorov power law f^-5/3 below the ion cyclotron frequency fci. Above this frequency, a steeper power-law is found, and is believed to be a "dissipative range" of solar wind turbulence. Magnetic field fluctuations in a range lasting two decades above fci are investigated using CLUSTER mission data. An increase of intermittency with frequency in this range indicates that turbulence cannot be characterized by a "dissipative range". Rather, we conjecture that the low-frequency Alfvénic turbulence gives place to some kind of magneto-sonic turbulence, generated by a different nonlinear cascade that is realized in a time shorter than the eddy turnover time, and related to dispersive effects (Hall cascade).

P.02 SOHO observations of plasma flows along coronal loops

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[2]Research Center for Astronomy, Academy of Athens

Loops are the basic structural elements of the solar atmosphere in low beta regions, particularly in the corona. Important progress has been made in recent years thanks to the SOHO and TRACE space missions, which provided opportunities for better studies of the loop morphology and their physical properties. In this work we use radial velocity measurements from the SUMER and CDS instruments aboard SOHO, in conjunction with a simple geometrical model, to reconstruct the velocity flow along loops. The flow appears to be uni-directional, with velocity maxima near the footpoints.

P.03 Spicules Flows near the Solar Limb from TRACE Ly-α observations

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We present preliminary results of a study of spicule flows on the disk near the limb. The observations were obtained with TRACE in a quiet region near the limb in the 1216 Ly-α Å band, and cover two periods of about 19 and 16 min respectively with a cadence of ~10 sec. The high temporal resolution of the images allows to follow the evolution of small bright features of the solar disk and the activity of the spicules beyond the solar limb. The analysis of the images shows that many bright features with lifetime of a few minutes shift toward the solar limb with a velocity of about 15 km/sec. Spicules show motions both in the radial direction and parallel to the solar limb.

P.04 A microstrip silicon detector for charge identification in Solar Energetic Particle's onboard Solar Orbiter

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In the last years, two separate populations of SEPs, with totally different origins, have been revealed on the basis of their abundances, ionization states and time profiles of the particles. Observations in different electromagnetic regions, as gamma-ray, X-ray, UV, optical and radio, allowed the associations of solar events to revealed cosmic rays.

The WiZard Collaboration, composed by Italian scientific institutions together with international partners, has been carrying out since 1989 a research program devoted to the study of the nuclear, isotopic and antimatter components of cosmic rays in a wide energy spectrum using balloon, satellite and Space Station-borne apparatus. The first steps of the research program were moved with the two missions NINA and NINA-2, whose goal was to detect cosmic rays of galactic and solar origin at 1 AU, between 10 and 200 MeV/n. The experiments were carried out respectively aboard the satellite Resurs-01-N4, launched in July 1998, and MITA, launched in July 2000 and still taking data. Futhermore, several experiments, Sil-Eye program, have been performed or are at present running on board the MIR and ISS Space Stations, dedicated to the study of the radiation environment on board the Stations. In June 2006 the payload PAMELA, a 470 kg multitasking detector, was launched in space onboard the Russian Resurs-DK1 satellite, for a 3-years long mission, with the main aim of studying dark matter and antimatter in the cosmic radiation. In addition, PAMELA will be able to measure the high-energy electron component in SEP's and search for the first time antiprotons in the solar radiation. The expertise of the WiZard Collaboration, whose coordination centre is the University of Rome Tor Vergata, is thus maximal in the construction of detectors sensitive to electrons and charged nuclei. In particular, all detectors flying so far were based on the silicon microstrip technology, where high knowledge was developed. During recent years, the Solar Physics group of Tor Vergata University has undertaken numerical simulations of solar flares triggered by photospheric convective flows.

The SOLO Mission assures the opportunity to continue the studies about Solar Energetic Particles started with the NINA and NINA-2 experiments, and continuing with PAMELA, but in an orbit much closer to the Sun (0.21 AU) and for a longer period of observation.

P.05 Liquid Crystal Variable Retarders for aerospace applications

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Polarization modulators based on Liquid Crystal Variable Retarders (LCVRs) are envisaged as a powerful and versatile solution whose main advantage is the lack of mechanisms (i.e. rotating plates).

An extensive test campaign has been carried out in order to demonstrate the feasibility of the LCVRs for the IMaX/SUNRISE magnetograph in environmental conditions similar to space conditions.

Analysis of the influence of vacuum, temperature, vibration, gamma and ultraviolet radiation was performed by measuring the effects of these tests on the optical retardance, the response time, the wavefront distortion and the transmittance, including "in-situ" measurements. Outgassing rates of the different parts of the LCVRs were also studied.

From the results obtained it can be concluded that these optical devices are suitable for SUNRISE and seem to be excellent candidates for aerospace missions as Solar Orbiter.

P.06 Ions of Jovian origin in the inner heliosphere? ACE and ULYSSES observations during days 290/2003 – 90/2004

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Low energy ion flux and spectral modulation with the Jupiter rotation period (~10 hours) were observed by Ulysses during its distant Jupiter Encounter, as long as Ulysses moved from north to south heliolatitudes, between days 290/2003 - 90/2004. This ~10 hour ion modulation was observed by Ulysses aroung times of passage of CIRs and in association with Jovian bKOM and nKOM ~10 hours emissions. During this extended time interval, surprising observations were made by ACE in the inner heliosphere. In particular, in this paper we analyze and discuss the characteristics of a series of short (~1-3 hours) duration ion bursts observed by ACE between 25-27, November 2003. At those times, ACE was et a distance of ~240 RE from Earth and located near IMF lines connecting Sun with Jupiter. The ion bursts were observed during times of ~10/5 hour quasi-periodic IMF directional variations and their onset / decay phases appear cross-field anisotropies; these observations suggest that a large scale particle layer was "near" ACE for a long time (~2.5 days) and approached / removed quasi-periodically (~10 hours) from the ACE spacecraft. During the main phase of ACE ion events the PADs suggest field aligned flows from the anti-sunward direction, but a comparison of simultaneous observations at ACE, Goetail and IMP-8 rather suggest that the Earth's magnetosphere / bow shock was not the source of the ~10 / 5 quasi-periodic ion flows. We suggest that the Jovian magnetosphere was most probably the source of the ~10 / 5 hour quasi-periodic ion bursts observed in the inner heliosphere in November 2003.

P.07 A three-dimensional study of flux emergence in the Sun

V. Archontis
University of St Andrews, Institute of Mathematics

We have performed 3D numerical MHD simulations to model the magnetic flux emergence in the Sun. We present evidence for the occurrence of field line reconnection, large-scale connectivity changes, current sheet formation and launching of cool and hot plasma jets in a series of experiments of the emergence of magnetized plasma from the solar interior into the outer atmosphere of the Sun. We obtain three-dimensional images that allow to understand the geometrical and physical relationship between those elements. The results are in good agreement with observations of X-Ray jets and of the formation of filamentary current sheets.

P.08 Systematic characterization of low frequency electric and magnetic field data applicable to Solar Orbiter

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[2] Space Science Centre, Sussex University, UK

We present a systematic and physically motivated characterization of electric and magnetic fields, as measured by the low frequency receiver on-board the Solar Orbiter spacecraft. The characterization is based on 36 quantities, which are second order in the field strengths, or in other words, which have physical dimension energy density. This approach has been useful in data analysis on previous space missions. However, many of these quantities lack an immediate physical interpretation, as they are not explicitly space-time tensors, but rather organized as a 6x6 matrix. To this end we propose a systematic representation of the 36 quantities as a set of space-time tensors and in so doing we show that all second-order quantities of electric and magnetic field data can have a physical meaning.

P.09 The faint drifting decameter radio bursts of the solar corona

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Decameter radio observations at high temporal (a few msec) and spectral (a few kHz) resolutions of the solar corona reveal the presence of numerous faint structures showing rapid drifts in frequency with time. Long series of dynamic spectra obtained with a digital spectropolarimeter at Nan?ay and Kharkov radio observatories have been analyzed. The main characteristics of these structures are presented. We show how they constrain the coronal density models between 0.5 and 5 Rs and we discuss possible mechanisms for the formation of these structures.

P.10 Time evolution of the Evershed flow

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We show spectropolarimetric evidence that moving magnetic features (MMFs) around sunspots are the continuation of Evershed flow beyond the visible limits of the penumbra. Two Evershed clouds are seen to move radially outward across the same penumbral filament. At a given moment, the clouds cross the penumbral boundary and continue as MMFs of opposite polarity. This effect, in turn suggests a magnetic connection between the MMFs and the sunspot magnetic field. Some other relevant evolutionary effects related to the Evershed flow are also discussed.

P.11 Learning about sensitivities of Stokes profiles

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The diagnostic properties of Stokes profiles can be studied properly by analyzing their response functions in different model atmospheres. In this contribution, we present two recent, simple analytical approaches that enable the user to many interesting calculations which help for designing instruments and specific observations with a given instrument. For instance, one can select a line for measuring a given physical parameter when using a specific instrument; finding the wavelength samples more suited to a given problem might no longer be an issue; the evaluation of the proper signal-to-noise ratio that is affordable for a given precision of the measurements is easy. And last, but not least, response functions shed some light in radiative transfer problems that induce, for example, cross-talk among free parameters of inversion codes. Sample spectral lines for IMaX (Imaging Magnetograph eXperiment, on board Sunrise) and VIM (Visible-light Imager and Magnetograph, on board Solar Orbiter) are discussed.

P.12 A Low Frequency Receiver for the Solar Orbiter mission

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The Low Frequency Receiver (LFR) is one of the main subsystems of the Radio and Plasma Wave (RPW) experiment that we wish to submit in response to a possible Announcement of Opportunity for the Solar Orbiter payload. It will be connected to two different sensor units: an electric antenna unit and a magnetic search coil unit that will be optimized to perform both quasi-DC and high frequency measurements. The LFR will be dedicated to analyse and process onboard the low frequency (LF) signals from a fraction of Hertz up to ~10 kHz, covering in situ measurements of the electromagnetic waves of the solar wind and extended corona. Due to the telemetry constraints different strategies for analysing and transmitting the data are defined, implying different onboard working modes. The design and the technological characteristics of the LFR block will be presented.

P.13 Inner Heliospheric Sentinels Spacecraft Concept

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[1] *The Johns Hopkins University Applied Physics Laboratory*
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The Sentinels mission is a key component of NASA's Living With a Star (LWS) program. The Sentinels Science and Technology Definition Team (STDT) has completed a study to define the science objectives, measurement requirements and observational strategies, and mission design for the Sentinels mission. The Inner Heliospheric Sentinels (IHS) are one of the three flight elements that implement the Sentinels mission. The four spin-stabilized IHS spacecraft are in elliptical heliocentric orbit with perihelia at ~0.25 AU and aphelia at ~0.75 AU. This orbit presents unique spacecraft thermal control and power challenges. The Johns Hopkins University Applied Physics Laboratory has demonstrated mission feasibility by developing a spacecraft design concept using conventional technologies that satisfies the science and mission requirements defined by the Sentinels STDT. This poster highlights aspects of the IHS spacecraft design concept.

P.14 Simulation of bright coronal loops over an active region

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We propose a simple model that may explain why, although the magnetic field fills all of the available volume in the space above an active region, only a relatively small number of thin bright loops are visible in coronal images. In our model, small scale photospheric plasma motions generate electric potential differences between coronal loop footpoints. To a first approximation, the magnetic field above an active region may be considered potential, and the atmosphere hydrostatic. We are thus in a position to compute the electric resistance and the electric current of each loop. The brightness is determined by Ohmic heating. The thickness of the bright loops is related to the photospheric motions' coherence length. We apply our model to reproduce the distribution of coronal loops above an MDI recorded active region.

P.15 Numerical studies for the Solar Wind Proton and Alpha Particle Sensor on-board Solar Orbiter

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The beginning of space activity at IFSI dates back to 1964 when ESA started its own space program in the field of satellites with terrestrial orbit apt to study the action exerted by the solar wind on the earth's magnetic field and the complicated ionospheric-atmospheric system. Since then, IFSI has participated to several international space projects collaborating to various plasma analyzers. In particular, IFSI team had a very active role in the realization of the ion spectrometry experiment CIS-2 for the CLUSTER mission, contributing to numerical studies apt to design the instrument geometry, mechanics, electronics, on-board software and data reduction.

Within the framework of Solar Orbiter, we are currently carrying out numerical studies apt to establish how the main moments of the solar wind particle velocity distribution function are affected by the particular phase-space resolution we choose. In particular, these results will be discussed taking into account that we need to cope on the one hand with the necessity of a high enough sampling rate to study the development of microinstabilities and, on the other hand, with the limited bit-rate allowed for data transmission.

Moreover, we will focus also on the implications that the corotating phase of the mission has on the choice of the FoV of the instrument.

P.16 A study of plasma wave noise levels using Helios 1 plasma wave data

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We use plasma wave data from the Helios spacecraft to study noise levels as a function of heliospheric radius. The Iowa HELIOS Solar Wind Plasma Wave Experiment instrument on Helios 1 measured electric field spectral density in 16 channels from 31.1 Hz to 178 kHz from a 16 m monopole (Helios 1). Noise in the lower frequency channels is found to increase linearly with the radial distance as the spacecraft approaches the Sun. However, when the frequency spectrum is scaled with the electron cyclotron or ion plasma frequencies, the power is found to decrease closer to the Sun. We interpret this in terms of the coupling between the antenna, spacecraft, and the plasma. In the resistive coupling regime, the antenna couples to the plasma potential through a photoelectron sheath and this circuit is shorted by photoelectron exchange with the spacecraft itself. We use a model of this coupling to compute the gain of the instrument (in the resistive regime); it agrees well with the observed increase in noise levels in the lowest channel. This indicates that the observed increase in wave noise is actually a gain change due to the plasma coupling. We discuss how these measurements may influence design of the Solar Orbiter Radio and Plasma Waves (RPW) instrument.

P.17 Resonance probe for measuring solar wind velocity

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A mutual impedance symmetric probe is proposed as a device for measurement of the plasma stream velocity in otherwise isotropic warm plasma. In its most simple design a small sphere is excited as a monopole with respect to "ground" on frequencies swept around the plasma frequency. Its field is monitored by two receiving spherical probes forming a dipole so that the exciter is in its center. In a non-streaming plasma it is a null device, so that its response is due solely to the asymmetry of the excited field in a moving plasma. The response depends on both the frequency and the drift velocity vector. We show here that such a probe can be used for measurement of the solar wind velocity. The response is calculated for a probe with dimensions much less than the Debye length and for the wind speed (u) lower than the electron thermal velocity (v). In principle, it allows for determining both the ratio (u/v) and the angle that the probe axis makes with the direction of the wind stream.

P.18 Coronal structures within polar coronal holes

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We present the current status of our research on the plume-like structures seen in polar coronal holes. It is now clear that there are two different structures that give rise to radial rays of brightness in the EUV and visible regions. Bright-point plumes emerge from local magnetic enhancements. Network plumes are structures rising above the boundaries of the supergranular network. The latter are likely associated with the mechanism for heating the corona and accelerating the fast solar wind. There are observational difficulties in resolving the 3-D structure of network plumes, which will be greatly helped by observing them from above the ecliptic plane, as will be possible from the Solar Orbiter.

P.19 Radial study of solar phenomena using raster scans. First results of the method for SUMER/SoHO rasters.

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Raster scans of the solar surface consist of 2-dimensional images of the Sun in a specific wavelength band or of 3-dimensional images with a narrow or wide spectrogram corresponding to each solar X,Y coordinate, measured in instrument resolution-depended intervals. Most studies of raster scans examine solar phenomena, either along the Solar X or the Solar Y direction. This happens mostly because the raster image represents quantized and not continuous data. So, it is impossible to apply a Cartesian to Polar coordinates transformation, since data pixels correspond to an area of the solar surface rather than to a dimensionless point. We present a method which “transforms” the raster data into polar coordinates or –to be more precise- bins the data by means of solar radial and angular coordinates. Thus, a study of a phenomenon can be easily performed along any radial direction and for various binnings along and across this direction. We also present the first results of this method applied to the early SUMER raster scans. The phenomena of spicules and limb broadening are examined radially. Our software plots a raster scan in rectangular coordinates but calculates and plots the results along a radius of a specific azimuth angle selected by the user.

P.20 Electron acceleration and transport during the November 1, 2004 Solar Energetic Particle Event

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The November 1, 2004 solar energetic particle event was associated with a 925 km/s CME originating on the backside of the Sun accompanied by type III and type II radio bursts. The event show proton acceleration beyond 50 MeV and electron acceleration beyond 10 MeV. The low $^{4}He/^{1}H$ ratio $\sim 2 \cdot 10^{-3}$ is typical for gradual events, but the event also showed a moderate ^{3}He enrichment commonly associated with impulsive events. Despite of the bad magnetic connection, the event show a relatively prompt onset, with the first energetic electrons arriving to 1 AU ~15 min after the start of the type II burst. We use different instrumental techniques to reconstruct the temporal evolution of the electron spectrum in the 0.2-10 MeV energy range using SOHO/COSTEP data in order to explain the electron acceleration and interplanetary propagation conditions during this event.

P.21 The energy, pitch angle and X-ray spectra of particles accelerated in single or multiple solar current sheets

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In this work, the acceleration of protons and electrons, by a Harris type Reconnecting Current Sheet (RCS) is analysed. Initially, the charged particles form a Maxwellian distribution at two million Kelvins. The final distributions of accelerated particles are studied for different parameters of the model that is, for the electric field, the magnetic field components strength as well as the particles injection position. An analytic interpretation of the shape of the final distributions as a function of the model parameters is given. The problem of particles acceleration due to their interaction with multiple RCSs is also aborded. The X-rays spectrum emitted by the electrons kinetic energy distribution, using a thick target model is computed and the implications for the study of solar flares with the Solar orbiter are discussed.

P.22 SOHO observations of a coronal loop compared with a 2D MHD loop model

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We present SOHO/CDS observations of a coronal loop, where Doppler shifts and proper motions indicate a unidirectional mass flow. The measurements of velocity, electron density and temperature (380000 K) along its length are compared with the results of a 2D MHD loop model. The derived energy balance, showing a stronger heating at the loop footpoints, as well as the knowledge gained from the MHD model are presented. The advantages of future Solar Orbiter observations for the study of coronal loops are discussed.

P.23 Scientific Justification for the Low-frequency Radio Measurements by the Solar Orbiter Mission

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The importance of the radio measurements in the frequency range 1-14 MHz has been demonstrated only recently by the Radio and Plasma Wave (WAVES) Experiment on board Wind. The shock-related radio emission in the 1-14 MHz range originates from a heliocentric distance of ~2-50 solar radii as demonstrated by the presence of coronal mass ejections remote-sensed by the solar and Heliospheric Observatory (SOHO) mission. Although several issues on the origin of shocks and their connection to solar eruptions have been clarified by the SOHO-Wind synergistic observations, some remain mainly because of lack of imaging and/or in situ observations at the shock source. For example, we do not have information on the Alfven speed in the region (<40 solar radii) of the interplanetary medium where the CME-driven shock is very strong and releases solar energetic particles. The Solar Orbiter mission will be able to address these issues by directly sampling the shock at a location where the radio emission originates to provide measurements of physical parameters for direct comparison with theory and modeling. We high light the science issues that can be addressed by a radio and plasma wave experiment on board the Solar Orbiter mission in combination with in situ measurements close to the Sun.

P.24 Developing Next Generation Spectrograph Technology for Solar Orbiter with the Rapid Acquisition Imaging Spectrograph (RAISE) Sounding Rocket Program

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The Rapid Acquisition Imaging Spectrograph (RAISE) is a next-generation high resolution imaging spectrograph to study the dynamics of the solar chromosphere, transition region and corona on time scales as short as 100 ms. High speed imaging from TRACE has shown that rapid motions and reconnection are central to the physics of the transition region and corona, but cannot resolve the differences between propagating phenomena and bulk motion. RAISE is uniquely suited to exploring this hard-to-reach domain.

RAISE is developing, and will fly for the first time, several new technologies critical to the success of next generation spectrographs, including 10 Hz readout Active Pixel Sensor (APS) cameras, toroidal variable line space (TVLS) gratings, and B4C optical coatings. The first flight of RAISE is scheduled for Spring 2007 (Flight 36.219) and will focus on the study of high frequency, small-scale dynamics of active region structures and the high frequency wave structure associated with these active regions.

This work is supported by NASA Grant NNG04WC01G to the Southwest Research Institute.

P.25 An Electron Proton Telescope for Solar Orbiter

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The Electron Proton Telescope (EPT) on Solar Orbiter will detect electrons from 0.02 to above 0.4 MeV, and protons and helium from below 0.02 to 7 MeV/nuc. Each sensor unit consists of a dual double-ended magnet/foil solid state detector particle telescope. This technique adapted from the Stereo Electron Proton Telescope (SEPT) allows to separately measure electrons and ions in the energy ranges given above. One of the major scientific goals of Solar Orbiter will be the investigation of particle acceleration and propagation at the Sun. Electrons, as measured by the EPT, play a cruical role in the study of energetic processes on the sun as they provide a direct link to the sites of particle acceleration. In addition, the electromagnetic emission these electrons produce is measured by the radio wave instrument aboard the spacecraft. Because electron pitch angle distributios are expected to be strongly beamed during the onset phases of a solar energetic particle events, the detector and electronic design of the EPT differs from the SEPT with an improved angular and energy resolution. Due to the high sensitivity of the EPT it will measure small energetic particle events and even nano flare particles, and thus can also give important contributions to the understanding of coronal heating.

P.26 Proton temperature anisotropy in the solar wind: Linear theory, observations and simulations

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We present a comparison between WIND/SWE observations of the proton temperature anisotropy $T_{\perp p} / T_{\parallel p}$ in the solar wind and predictions of the Vlasov linear theory. The observed proton temperature anisotropy seems to be constrained by oblique instabilities, by the mirror one and the oblique fire hose, whereas the linear theory predicts a dominant role of the proton cyclotron instability and the parallel fire hose.

The discrepancy between the linear theory and observations is investigated in the case of $T_{\perp p} / T_{\parallel p}$ using the hybrid expanding box simulations. The simulations show that both the parallel and oblique fire hoses constrain the proton temperature anisotropy with the latter one constituting an ultimate anisotropy frontier. These simulation results are in a agreement with the observations and may explain the apparent discrepancy between the linear theory and observations.

P.27 Magnetic Wave Field Measurements in the Solar Orbiter Project

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Although much is known concerning the waves which exist in the solar wind near the orbit of the Earth, there are still many opened questions concerning the waves which occur much closer to the Sun. At the present time the closest measurements to the Sun have been obtained from the Helios 1 and 2 spacecraft at approximately 0.3 AU. Based on these observations, we discuss the characteristics of the waves expected to be present at 0.2 AU and the magnetic field sensors required to measure them in the frame of Solar Orbiter project.

P.28 X-ray Imaging and Spectroscopy with Solar Orbiter

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Solar flares are the most powerful explosions in our solar system, releasing up to 1e32-1e33 ergs in ~10-1000 s. The flare-accelerated ~20-100 keV electrons appear to contain a significant fraction, ~10-50 %, of this energy, indicating that the particle acceleration and energy release processes are intimately linked.

X-ray observations are excellent diagnostics of energetic electrons (> few keV) and hot (>1 MK) thermal plasmas providing quantitative measurements such as total energy in energetic electrons.

This presentation will briefly summarize an instrumental concept for the HXR telescope onboard Solar Orbiter and will discuss scientific questions that can be answered including a discussion on coordinated in-situ/remote-sensing observations.

P.29 Ionic Charge State Measurements of Suprathermal Ions on Solar Orbiter

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The observation of ionic charge states of suprathermal and energetic ions has been found to be a very useful diagnostic tool. It is important in the determination of the sources as well as injection and acceleration processes involved in the generation of the suprathermal and energetic particle populations in interplanetary space. To be able to distinguish between singly and multiply charged ions is crucial to the question of how much interstellar and inner-source pickup ions contribute to accelerated populations relative to solar wind. In addition, it has become clear that pickup ions are accelerated much more efficiently than solar wind ions, although the detailed mechanism for this selectivity is far from being understood quantitatively. At the other end of the charge-state scale highly charged heavy ions from impulsive flare events appear to populate interplanetary space almost continuously, contributing to a ubiquitous source population for effective further acceleration that has only become visible with recent more powerful instrumentation onboard ACE. An important feature of this population is the dramatic increase in charge state in the suprathermal region from a few 10 kev/amu to a few 100 keV/amu, which can only be explained by stripping of these ions during their acceleration then presumably at low altitudes in the solar atmosphere. Solar Orbiter will be an excellent platform to study evolution of these diverse populations with distance from the sun in a region where important production, injection, and acceleration processes occur. We will present a concept how to include in an efficient way the capability to measure ionic charge states by integrating an electrostatic analyzer into the suprathermal ion sensor (SIS) currently on the Solar Orbiter strawman payload.

P.30 The performance of the SO-VIM instrument: Effects of instrumental noise and lossy data compression

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Spectropolarimetric observations in photospheric lines reveal a wealth of information on physical parameters of the solar atmosphere like magnetic field strength and direction or the line-of sight velocity. These observations require the measurement of the four Stokes parameters at a sample of N wavelength positions around the core of the spectral line, resulting in 4N images for one observation. The VIM instrument on board Solar Orbiter is capable of performing these measurements. However, the data rate to transfer all 24 images within the required time cadence is not sufficient. In this poster we use realistic, three-dimensional MHD simulations in order to simulate realistic science data provided by VIM which are then used to test various compression techniques. We conclude that lossy data compression and instrumental noise have similar effects on the output data.

P.31 Space borne solar coronagraphs external occulter apodization

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All solar coronagraphs are based on the simple but genial idea of Bernard Lyot of an artificial eclipse of the solar disk. A lot of solar coronagraphs have been built since the first model of 1932. The most critical issue in the design of a coronagraph is the suppression of the stray light due to the solar disk high emissivity. Space borne coronagraphy gives the possibility to use external occulting systems, to considerably reduce the instrumentally scattered solar light. The first step in designing an externally occulted coronagraph is the design of the apodization system for the external occulter. This poster shows a general and comprehensive reflection on the physics of apodizing systems. Several apodizing systems are reviewed and compared together.

P.32 A Faraday Cup Solar Wind Experiment for Solar Orbiter

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We propose a design for a Faraday Cup instrument that could perform the measurements of solar wind hydrogen and helium on Solar Orbiter. Considering the instrument requirements described in the straw man payload, a Faraday Cup has many virtues in comparison with other instrument designs. First, the Faraday Cup is not sensitive to contamination. Second, the detector (a metal collector plate) is insensitive to radiation and photons. Experience with the Faraday Cup system onboard the Wind spacecraft has indicated drift in the absolute response of the instrument of less than 0.1%/decade. Such stability is important for an instrument on a spacecraft operating alone in a harsh environment. Third, the Faraday Cup would have a wide-angular acceptance (45 degree half-angle cone) enabling accurate measurements of Alfven wave fluctuations. Finally, the Faraday Cup has a demonstrated track record of accurate measurements of ion beams and temperature anisotropies that have led to new scientific understanding of the instabilities that will be a key part of Solar Orbiter. We propose a Faraday Cup that would make rapid 10 Hz measurements of three-dimensional properties of solar wind hydrogen and helium: velocities, temperatures, heat fluxes, beams, and anisotropies. A subset of those data would be sent to Earth, but the high time resolution measurements could be correlated on board with measurements of the local electric field, leading to a new understanding of the physics of dissipation and heating in the solar wind.

P.33 MHD turbulence and spatio-temporal intermittency in solar coronal loops

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Several works have shown in recent years that magnetohydrodynamic (MHD) turbulence plays a relevant role in the dynamics of the magnetic loops of the solar corona. We will discuss some issues related to the MHD turbulence occurring in coronal loops, mainly focusing on the role and on the modeling of the spatio-temporal intermittency associated with the turbulent cascade.

P.34 Energetic particles as tracers of magnetic connectivity and solar injection

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We present several advances expected in energetic particle research in the context of possible observations with the Solar Orbiter and the Inner Heliospheric Sentinels (IHS). Since propagation effects are expected to have a much smaller influence on particle profiles closer to the Sun compared to an observer at the Earth, energetic particle observations obtained with Solar Orbiter and IHS will provide a more accurate estimation of the onset times of solar energetic particle events and enable the separation of different particle injections. Furthermore, fine-time resolution energetic particle measurements obtained by SOLO along with the more detailed information on solar activity available from SOLO, from other spacecraft, and from ground-based instruments, compared e.g. to Helios, will make possible important investigations of the relative timing of injection between energetic electrons and ions in close linkage with the plasma and radiation conditions in their source regions on the Sun. We will also demonstrate how the intensities and angular distributions of near-relativistic electrons – which are ideal field line tracers - can be used to provide information concerning the near-Sun structure and connectivity of Interplanetary Magnetic field lines threading through Interplanetary Coronal Mass Ejections (ICMEs) in the inner heliosphere.

P.35 Observations of Solar Activity by the Radiospectrometer Aboard the Solar Orbiter

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During solar flares an enhanced emission of nonthermal radio radiation occurs indicating the generation of energetic electrons in the corona. Since the nonthermal solar and interplanetary radio radiation is assumed to be emitted near the local electron plasma frequency, the solar radio radiation around 1 GHz and 100 kHz is emanated from the low corona near the transition region between the chromosphere and the corona and from the interplanetary space at a distance of 60 solar radii from the Sun. A radiospectrometer is designed to work in the frequency range 100 kHz - 20 MHz as a part of the Radio and Plasma Wave Analyser (RPW) aboard the Solar Orbiter. The data recorded by this instrument together with the ground based observations of the Sun by LOFAR in the range 30-240 MHz will allow to study plasma processes associated with energetic electrons, e. g. generation energetic electrons by magnetic reconnection, shock accelerated electrons beams, energetic electrons trapped in coronal loops, in the solar corona.

P.36 Lithium Niobate etalons for space applications

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Selecting a narrow bandpass (< 100 mA) with an optical filter can prove challenging. Traditional solutions are Michelson interferometers, birefringence filters and etalons. If the weight of the filter is an issue for selecting which device will be used in an instrument, Lithium Niobate etalons can prove to be the best choice. As solid etalons, they consists of a thin (several hundred microns) $LiNbO_3$ crystal with adequate coatings and conductive layers. Tuning is achieved by applying a different voltage to the etalon (in the kVolts range) but without using any moving component. These contributions reports on extensive tests made for $LiNbO_3$ etalons for the IMaX/SUNRISE magnetograph which uses one such etalon in a double pass configuration. The tests describe the speed, thermal, tilt and voltage tunning performance of these devices.

P.37 Design and Calibration of the Solar Electron and Proton Telescope for STEREO-IMPACT

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A knowledge of the three-dimensional distribution of energetic electrons and protons is essential for characterizing the dynamic behaviour of CME associated and solar flare associated events. The Solar Electron and Proton Telescope (SEPT) consists of two dual double-ended magnet/foil particle telescopes which cleanly separate and measure electrons in the energy range from 30 - 450 keV and protons from 60 - 7000 keV and provide anisotropy information. SEPT was designed and built by a collaboration of the University of Kiel, Germany, and ESA ESTEC, The Netherlands, for the STEREO mission of NASA's Solar Terrestrial Probes program. As the twin spacecraft are not spinning, special efforts are made to acquire anisoptropy information in four look directions: SEPT-E observes in the ecliptic plane along the nominal Parker spiral magnetic field direction both forward and backward, SEPT-N/S observes out of the ecliptic plane perpendicular to the magnetic field both North and South. The particle energy is measured in a stack of two solid state detectors (SSD), 300 micrometer thick, and operated in anti-coincidence to reject penetrating particles. One SSD looks through a parylene foil and its partner through the air gap of a magnet system. The foil leaves the electron spectrum essentially unchanged but stops protons of energy up to the energy of electrons (~450 keV) which penetrate the SSD. The rare earth permanent magnet (NdFeB) is designed to sweep away electrons below 450 keV, but leaves ions unaffected. We present the design, Monte-Carlo simulations, and calibration measurements with conversion electrons from radioactive sources, cosmic ray muons, and proton and alpha beams from Van-de-Graaff and cyclotron accelerators.

P.38 NRL EUV Imager: The Solar EUV Atmospheric Research of the Corona and Heliosphere (SEARCH) experiment.

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To be determined

Achieving the Solar Orbiter primary science goals requires knowledge of the fine structure of the solar atmosphere from chromospheric to coronal temperatures, and the structural links between these different temperature regions. An EUV imager is an ideal instrument for providing this crucial information, and the Solar Orbiter mission gives a unique opportunity to investigate the fine structure of the chromosphere, transition region, and corona at unprecedentedly high spatial resolution. We present a concept from the US Naval Research Laboratory (NRL) for providing an Extreme Ultraviolet (EUV) Imager for the Solar Orbiter mission, the "Solar EUV Atmospheric Research of the Corona and Heliosphere" (SEARCH) experiment. The SEARCH instrument has been designed to provide the maximum science possible within the strawman spacecraft and environmental constraints. The proposed instrumentation includes a single structure containing a High Resolution Imager (HRI) with passbands ranging from 171Å to 630Å and a single (195Å) Full Sun Imager (FSI) low resolution channel.The HRI telescope is based upon an innovative design that achieves five high resolution channels instead of the baseline 2-3 channels, while still meeting the instrumental resource requirements (e.g. mass, power, volume, thermal input, telemetry) outlined in the Solar Orbiter Payload Definition Document. This significant improvement uses a single mechanism (rotating wheel) to select an appropriate primary mirror for each channel. The mechanism has direct heritage to one developed by NRL for the Solar-B EIS experiment and has been exhaustively life and environmentally tested.

P.39 Aspects of the RPW antennas of SOLAR ORBITER

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The Radio and Plasma waves Analyser (RPW) of SOLAR ORBITER will be designed to receive electrostatic as well as electromagnetic waves, therefore enabling in-situ as well as remote sensing measurements. The Plasma Waves Analyser (PWA) will cover the in-situ measurements while the Radio Spectrum Analyser (RAS) will be responsible for the remote sensing. Both subsystems will share the same sensors, in particular the electric field antennas (RPW-antennas).

Quasi-thermal Noise Spectroscopy and Direction Finding, i.e. the technique to determine the direction of incidence and the state of polarization from the measured data, will play an important part in the science of this mission. The magnitude of the effective length vector has to be at least as large as the dimension of the local Debye length if quasi-thermal noise spectroscopy is to be performed. The shape of the spacecraft and the base capacitance of each antenna influences the effective length vector but this influence can be calculated.

The RPW experiment is very similar to the SWAVES experiment on the STEREO spacecraft. In this paper we utilize our experience with the SWAVES antennas to discuss the mentioned requirements and limitations to be expected on SOLAR ORBITER.

P.40 High Resolution Single Photon/Particle Imaging Detector with 4 Dimensional Output: Absolute Time-of-hit, X - Y Position, and Particle Energy/Mass, Proposed for the Solar Orbiter Mission

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Advanced time, position, and mass (for particles) detectors are strong enabling technology for many science applications such as UV spectrometers, energetic neutral atom imagers, energetic particle analyzers, ion/electron plasma analyzers, mass spectrometers, laser imagers, x-ray imagers. The applications of such detector cover a very broad multi-disciplinary range from space physics, astrophysics, medical imaging, and industrial applications. The detector system includes:

a) A two stack or Z-stack MCP

b) Option for a thin foil or photo-cathode in front of the MCP

c) 1D or 2D delay line anode

d) Fast TOF electronics with <50ps time resolution

e) Standard matlab SW for data acquisition and visualization

A key component to this detector is the time of flight chip capable of measuring end-to-end time differences with time resolutions <50ps at several MHz and low power. The particle mass is estimated from the total charge released in the detector. The detector achieves time of hit accuracy <50ps, X-Y position resolution <20um in a field of 2048 x 2048 pixels and adjustable speed 10MHz at 256 x 256 pixels, and 1MHz at 2048 x 2048 pixels. The total-charge analysis is at 10-bits. The technology is customizable for detection area, size and geometry, as well as power -speed/resolution tradeoff.

P.41 Cool Loops in the Quiet Sun Transition Region: Observational Evidence from VAULT and the Promise of Solar Orbiter

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One of the most enigmatic regions of the solar atmosphere is the lower transition. Traditional models which assume that the lower transition region emission comes from the base of structures reaching coronal temperatures, predict emission for $\approx T < 10^5$ K which is orders of magnitude smaller than what it is observed. It was therefore proposed that the lower transition region has a second structural component: very small cool loops which do not reach coronal temperatures. We report on the first spatially resolved observations of such structures made by the Very High Angular Resolution Ultraviolet Telescope (VAULT) sounding rocket. Thanks to VAULT's superior sub-arcsec resolution we were able to see a bounty of loop-like structures in the quiet Sun network. We then compared the observed intensities of these structures with radiative transfer models of cool loops. The very good agreement between the model and the observations indicates that the observed loop-like structure can be indeed cool loops. We finally discuss our findings within the light of the ultra-high spatial resolution long-duration observations by the remote sensing spectroscopic, imaging and magnetographic instrumentation of Solar Orbiter.

Research supported by NASA and ONR

P.42 Thermal feasibility study of the Solar Orbiter Visible Light Imager and Magnetograph (VIM)

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The aim of the Visible Light Imager and Magnetograph (VIM) is to determine the morphology and dynamics of magnetic field structures and plasma motions in the photosphere. The instrument consists of a High Resolution Telescope (HRT) with an aperture of 16 cm and a Full Disk Telescope (FDT) of 1.6 cm. Two factors make the thermal control of VIM a challenging task: the high eccentricity orbit with a perihelion of 0.22 AU and an aphelion of 1.4 AU, together with a relatively large aperture of the HRT.

The thermal solution for VIM includes different elements devoted to minimise the heat input into the instrument: first an entrance filter that allows passing a bandwidth of 50 Å, what in terms of energy means 1% of the incoming solar heat flux; second a thermal baffle that prevents the instrument from solar irradiation in case of mispointing; third, an off-axis configuration that, despite its complexity, avoids solar irradiation directly impinging on the back side of the secondary mirror (M2), and fourth the use of a prefilter that reflects part of the energy coming from M2 back onto the thermal baffle.

A thermal mathematical model of the system has been established to obtain the temperatures of the main elements of the system. Once found a solution for the hot, most critical case, that allows keeping all the devices within their appropriate temperature ranges, the performance during the operational cold case (0.9 AU) and survival cold case (1.4 AU) has been studied.

P.43 Magnetospheric optics for solar cosmic rays producing ground level enhancements

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Cosmic ray particles arriving at the vicinity of the Earth propagate inside the magnetosphere and finally access low-altitude satellites or ground level neutron monitors, if their energy is sufficiently high. The main tool for studying the details of the cosmic-ray particle transport is a numerical back-tracing of the protons trajectory in a magnetospheric field model. Therefore, the definition of the asymptotic windows of allowed trajectories for each neutron of the worldwide network provides us with crucial information on the Earth's "magnetospheric optics" for primary cosmic rays. In this work the asymptotic directions of viewing for a significant number of neutron monitors stations widely distributed around the globe covering a wide range of longitudes and rigidities have been calculated using the Tsyganenko (1989) magnetospheric field model for the time period of the big solar cosmic ray event of January 2005. In this case the neutron monitor network has been treated as a multidimensional tool that gives insights into the arrival directions of solar cosmic ray particles as well as their spatial and energy distributions during extreme solar events. Moreover, peculiarities and differences of the secondary solar particles intensities recorded at neutron monitor stations related to their different asymptotic directions of viewing during the ground level enhancement of 20 January 2005, will be discussed.

P.44 First Results from EUNIS-06

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The Extreme Ultraviolet Normal Incidence Spectrograph (EUNIS) is an extreme ultraviolet solar spectrometer with high efficiency and high spectral resolution, carried on a Black Brant sounding rocket. EUNIS has over 100 times the throughput of the highly successful SERTS payloads that have preceded it. The objectives of EUNIS are,

- To probe the structure and dynamics of the inner solar corona
- To obtain spectra with a cadence as short as 2 sec, allowing unprecedented studies of the physical properties of evolving and transient structures
- To study diagnostics of wave heating and reconnection at heights above 2 solar radii, in the wind acceleration region
- To provide absolute intensity calibration of orbital instruments, including SOHO/CDS and EIT, TRACE, Solar-B/EIS, and STEREO/EUVI
- To demonstrate new technology in flight

On its first flight, EUNIS obtained 145 science images in each of two wavelength channels (170–205 Å and 300–370 Å) near NOAA Active Region 10871 during its 7 minute flight. The instrument was subsequently calibrated in the "Blue Tank" at RAL. Analysis of both the calibration data and the flight data is underway.

EUNIS detectors employed six 1K x 1K active pixel sensors (APS), single-chip CMOS imaging systems with low power consumption. The APS sensors were developed by JPL (B. Pain and S. Seshadri of the JPL CMOS Imaging Group) to anticipate orbital instruments with highly constrained mass and power budgets. EUNIS-06 was the first space test of science-quality APS arrays. The arrays, operated at ambient temperature, performed nominally.

EUNIS has provided a demonstration of the next-generation spectrometer technology necessary for the EUV spectrometer on the Solar Orbiter mission.

P.45 A Reduced MHD Turbulence Numerical Approach on coronal loop heating: Deriving scaling laws with respect to photospheric time-scales

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The study of turbulent mechanisms has been recognized as a crucial point to the understanding of coronal heating. We have carried out incompressible 2D Reduced MHD simulations to investigate the long time statistical behavior of a coronal loop subject to magnetic forcing. We are interested in particular in studying how dissipation and evolution of the 2D system depends on the time scales accociated with the photospheric forcing. To this effort we apply a large scale quasi-stationary coherent forcing firstly constant in time, and secondly variable in time over a range of timescales compared with the internal dynamical timescale of the turbulence.

Our simulations of the average energy dissipation and the spectral and spatial distribution at a given time demonstrate the role of noise in triggering resistive instabilities and subsequent cascades, but more importantly the self-organization of the loop at large scales via an inverse MHD cascade, the highly intermittent response of the system indicated by strong peaks in the power dissipation and the strong nonlinearity of the effect.

To quantify the nonlinearity of the response we derive for the time constant case scaling laws against resistivity of the difference between the numerical solution and the linear approximation as well as of the time it takes the system to reach the peak after exceeding the linear approximation solution.

We finally compare the results with the full time dependent forcing case and discuss the implications.

P.46 The HERSCHEL/SCORE visible and UV coronagraph

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The Herschel (HElium Resonant Scattering in the Corona and HELiosphere) experiment, to be flown on a sounding rocket, is designed to investigate the helium coronal abundance and the solar wind acceleration region by obtaining the first simultaneous observations of the electron, proton and helium solar corona. The HERSCHEL payload consists of several instruments that image the solar corona in the EUV and in the visible from the disk to the extended corona. SCORE (Solar CORonograph Experiment) is a coronagraph that has the capability of imaging the solar corona from 1.4 to 3.5 solar radii in the EUV lines of HI 121.6 nm and the HeII 30.4 nm and in the visible broadband polarized brightness. The SCORE coronagraph consists of an externally occulted reflecting telescope in off-axis gregorian configuration with a novel design in the stray light rejection. The use of multilayer mirrors in normal incidence makes possible the observations in all three wavelength bands with the same telescope. HERSCHEL/SCORE aim is also to test in space the performances of this design and establish a proof-of-principle for the Ultraviolet Coronagraph of Solar Orbiter.

P.47 Considerations of Solar Orbiter electric antenna modelling

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On board of the Solar Orbiter the Radio and Plasma Wave (RPW) experiment comprises an important part by the measurement of electromagnetic radiation of solar and coronal origin. The RPW search coils and electric antennas are connected to spectrometers comprising various frequency ranges. Of particular interest is the configuration of the RPW antennas attached to the lateral side of the Solar Orbiter spacecraft body, since both the mutual orientation of the antenna rods as well as the attitude of the overall antenna system with regard to the spacecraft configuration plays an important role for the reception properties of the RPW experiment.

Antenna model configurations can be analyzed by means of calibration methods as there are wire grid modelling and rheometry, with specific pros and cons with regard to the parameter space of antenna definition. Details will be given on the areas of application of both methods, their frequency ranges and accuracy limits, and first estimates on the optimization of orientation of the RPW antenna system.

P.48 Application of PRASSADCO to the Solar Orbiter data of the Low Frequency Receiver.

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Low frequency (0 - 10 kHz) waves will be recorded by the planned Low Frequency Receiver (LFR) of the Radio and Plasma Wave (RPW) experiment for the Solar Orbiter mission. Interesting solar wind waves, as the ion-acoustic and whistler-mode waves appear in this low frequency range. A sophisticated on board data processing and data reduction software can significantly increase the scientific content of these data at a given telemetry bandwidth. On-board spectral analysis will allow us to obtain spectral matrices of three magnetic and three electric components from search coils and electric antennas, respectively. From these matrices we plan to identify the basic wave properties: wave mode, polarization and wave vector direction. We plan to implement analysis techniques which are routinely used for the CLUSTER and DEMETER data (PRASSADCO routines for propagation analysis).

P.49 Space qualification of a thin wafer lithium niobate etalon for the Visible light Imager and Magnetograph (VIM)

Udo Schühle, Shibu K. Mathew, Sami K. Solanki, Valentin Martinez-Pillet

To map the magnetic field at the solar photosphere a magnetograph is needed with a narrow band spectral filter that can be tuned within the linewidth of a strong photospheric line. To achieve the spectral resolution needed, a double Fabry-Perot etalon can fulfill the requirements. Typically, a couple of etalons are needed with spacings in the submilimeter range. Technically, solid wafers with the appropriate thickness have certain advantages over air-spaced etalons due to their much lower mass and volume requirements. In addition, a lithium niobate crystal wafer, polished to a high finesse and with conductive coating on both surfaces, can provide the ability to tune electrically within the required spectral range. We have undertaken first studies to space qualify a lithium niobate wafer of 70 mm size. We show the results of the mechanical mounting and vibration tests and the thermal cycling tests.

P.50 Thin silicon carbide coating for a primary telescope mirror of a VUV imaging instrument for Solar Orbiter

Udo Schühle, Hein Uhlig, Werner Curdt, Thorsten Feigl, Armin Theissen, Luca Teriaca

High-resolution spectroscopy and imaging at vacuum-ultraviolet wavelengths requires apertures of several centimeters diameter to achieve the desired image quality and signal levels. The thermal environment of Solar Orbiter, however, sets very tight limits on the instrument's aperture size. To reduce the thermal heat load on the primary mirror, a dichroic design that does not absorb the solar visible and near infrared but preferentially reflects the VUV radiation can greatly relax such technical difficulties. We have made experimental studies with thin SiC coatings on quartz plates to evaluate their reflective properties in the VUV spectral range between 58 nm and 123 nm and discuss the results in relation to their visible and near infrared optical properties. A thin SiC coating of 10 nm thickness is shown to be a very promising compromise between high VUV reflectivity and low vis/IR absorption.

P.51 A possible configuration of the Visible-light Imager and Magnetograph on Solar Orbiter

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The Visible-light Imager and Magnetograph (VIM) is one of the key instruments on Solar Orbiter. It will centrally address 3 of the 4 top-level science goals of the Solar Orbiter mission, besides providing a host of further scientific results that go beyond these. Here we describe some of the basic properties of the Instrument and show a possible configuration.

P.52 On-board high frequency waveform processing for the RPW instrument

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The Solar Orbiter spacecraft will be equipped with a state of the art wide band receiver (RPW) designed to record electric and magnetic field waveforms in a broad frequency range reaching up to several hundred kHz. One of the main scientific objectives of the instrument is to provide measurements of Langmuir-like waves that are frequently observed in the solar wind in association with solar bursts. Such multi-component measurements of high frequency waveforms produce a large volume of data and therefore place large demands on the telemetry bandwidth of the spacecraft. To maximize the scientific yield of the instrument, we propose multiple techniques of data pre-processing, data reduction and selection of events that can be implemented on-board in order to reduce the telemetry demands. These algorithms take advantage of the fact that most of the energy of Langmuir waves is concentrated within a relatively narrow frequency band and observed waves are coherent over a large number of wave periods. Wide band waveforms are therefore effectively oversampled and can be demodulated and decimated to reduce the data volume while retaining most of physically relevant content. The performance of the techniques was tested on solar wind waveform data observed by CLUSTER and compared with general purpose data compression algorithms.

P.53 Electron Anisotropy Constraint in the Solar Wind

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We present a statistical study of solar wind electrons using data from several spacecrafts missions (HELIOS-I, CLUSTER-II and ULYSSES) collected in the ecliptic plane covering the radial distance from the Sun from 0.3 up to 4 AU. We focused on the electron temperature anisotropy which control mechanisms are still not well understood. For this purpose we looked at the temperature anisotropy as a function of two important parameters, namely the electron collisional age A_e defined as a number of collision suffered by an electron during the expansion of the solar wind and the electron parallel plasma beta $\beta_{\parallel}$, to see whether the electrons are constrained by some instabilities or driven by collisions. The radial evolution of these relations were also examined. The temperature anisotropy was computed by fitting the measured electron velocity distribution functions (eVDF) with a core-halo model defined as a sum of a bi-Maxwellian and a bi-Kappa function representing the core and halo population respectively.

P.54 Imaging and spectroscopy around the H I Lyman alpha line: expected radiometric performances

L. Teriaca, U. Schuehle, W. Curdt

We present the expected radiometric budget and performances of both a telescope (imager) and a spectrograph operating at the H I Lyman Alpha 121.57 nm line.

For the imager, the adopted technical solution yields very high count-rates with a spectral purity above 90%, allowing monochromatic imaging of the lower transition region at unprecedented temporal and spatial resolution.

For the spectrograph, a two-mirror, normal-incidence optical design and a selective coating of the detector surface (photocathode on micro-channel plate) can provide a compact spectrograph with high radiometric efficiency, enabling the instantaneous recording of the large wavelength range from 116.4 to 126.6 nm (58.2 to 63.3 nm in 2nd order). We show that the adopted scheme makes possible to clearly separate the two spectral orders at the required spectral locations allowing us to select a variety of solar emission lines formed at temperatures ranging from the chromosphere to the corona and including also a flare line.

P.55 Spectral analyzer of the Velocity and Imaging Magnetograph of the Solar Orbiter Mission

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We will present the concept of the spectral analyzer of the Velocity and Imaging Magnetograph of the Solar Orbiter Mission. We will explain the scientific and technical trade off analysis that leads to the current concept. We will pave the road for identifying the critical path to the development of the spectral analyzer.

P.56 Fine radio structures during major solar events observed with Artemis IV

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ARTEMIS IV is a Multichannel solar radiospectrograph operated by the University of Athens, located at Thermopyle Satellite Station, Greece (for a complete description, see Caroubalos et al., 2001) see http://www.cc.uoa.gr/artemis

ARTEMIS is located at longitude 22.41 degrees east, latitude 47 north. Observations cover the frequency range from 20 to 650 MHz. The spectrograph has a 7-meter moving parabolic antenna for 110 to 650 MHz and a stationary antenna for the 20 to 110 MHz. There are two receivers operating in parallel, one sweep frequency for the whole range (10 spectrums/sec, 630 channels/spectrum) and one acousto-optical receiver for the range 270 to 470 MHz (100 spectrums/sec, 128 channels/spectrum). The data acquisition system consists of two PCs (equipped with 12 bit, 225 ksamples/sec DAC, one for every receiver) ,Windows operating system, connected through Ethernet. The daily operation is fully automated: pointing the antenna to the sun, starting and stopping the observations at preset times, data acquisition, and archiving on DVD. The whole system can be controlled through modem or Internet.

We analyse the fine structure of the type IV radio burst, during the main phase several major solar event recorded by the radiospectrograph ARTEMIS-IV, in the 20-650 MHz (10Hz sampling rate) and the 270-450 MHz (100Hz rate) range. We focus on variations in frequency drift rate and repetition rate of fibres bursts.

P.57 Low frequency electric field and density fluctutation measurements on Solar Orbiter

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Solar Orbiter will orbit the Sun down to 0.2AU distance allowing detailed in-situ studies of important but unexplored regions of the solar wind in combination with coordinated remote sensing of the Sun. In-situ measurements require high quality measurements of particle distributions and electric and magnetic fields. We show that such important scientific topics as identification of coronal heating remnants, solar wind turbulence, magnetic reconnection and shock formation within coronal mass ejections all require electric field and plasma density measurements in the frequency range from DC up to about 1000 Hz. We discuss how such measurements can be achieved using double-probe technique. We present possible instrument implementations.

P.58 The Low Energy Telescope for Solar Orbiter

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The Energetic Particle Detector suite of the Solar Orbiter consists of several sensors covering the energy range from suprathermal region to beyond 100 MeV/n. The Low Energy Telescope (LET) is proposed as a part of this package for measuring protons and isotopes of helium roughly in the energy range 1-20 MeV/n and heavy ions up to 60 MeV/n. The sensor is basically a silicon detector telescope relying on the well-proven dE-E method of particle identification. The sensor has three view cones, determined by two circular front detectors, with angular separations of 45 degrees. By division of each of the front detectors in two concentric active areas, the field of view of protons and helium in each three directions is limited to 14 degrees (geometric factor 0.0024 cm2sr), while that of heavy ions is 40 degrees (geometric factor 0.17 cm2sr). With this arrangement, the total full opening angle of the sensor is 130 degrees. In order to have sufficient angular coverage for resolving particle pitch-angle distributions, three LET units will be accommodated in various locations on the spacecraft with two sensors pointing in the orbital plane and one perpendicular to this plane. The allocated total mass, power, and bit rate for the three units are 2.0 kg, 2.3 W, and 1000 bits/s, respectively.

The primary science objectives of LET include investigation of the sources of energetic particles in the heliosphere, the processes responsible for particle acceleration, and the sources, dynamics and effects on the inner heliosphere of eruptive events. LET is particularly suitable for observing energetic storm particle events in the vicinity of the Sun during passage of interplanetary shock waves driven by coronal mass ejections. The capability of distinguishing helium isotopes and identifying heavy ions combined to a good time resolution will be used to study the acceleration processes even in small gradual particle events, while the directional sensitivity of the sensor will be applied in reducing the ambiguities in the source locations and acceleration processes introduced by the interplanetary transport of particles.

P.59 Evidence of an association between the presence of penumbrae and strong radial outflows in sunspots

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Time series of high-resolution images of the complex active region NOAA 10786 are studied. The observations were performed in G-band (430.5 nm) and in the nearby continuum (436.3 nm), on July 9 2005 at the Solar Swedish Tower (1m-SST) telescope in La Palma. Granular proper motions in the surroundings of the sunspots have been quantified. A large-scale radial outflow in the velocity range 0.3 - 1 $km.s^{-1}$ has been measured around the sunspots by using local correlation tracking techniques. However, this outflow is not found in those regions around the sunspots with no penumbral structure. This result evidences an association between penumbrae and the existence of strong horizontal outflows (the moat) in sunspots.

P.60 Prospects of the Solar Orbiter mission for observing the solar corona

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Solar Orbiter is a mission selected in September 2000 by the European Space Agency (ESA) for the definition study phase. It is currently foreseen to be launched no earlier than October 2015. Solar Orbiter will describe elliptic orbits with a large range of heliocentric distances, from 0.21 to 0.6 AU (a factor 3 in the geometric conditions). It will achieve co-rotation with the Sun (at repeated perihelion passages) and its heliographic latitude will progressively increase up to 38 degrees. Furthermore, the spacecraft will have an offset pointing capability (up to +/-1.3° at 0.21 AU) to target any point of the solar disk. Apart from these specific constraints, thermal aspects are obviously a key issue for this mission. These constraints are very restrictive using a classical coronagraph; particularly past coronagraphs have always been optimized for fixed geometric conditions. Since we are convinced that imaging the corona is important for Solar Orbiter, we initiated an effort to conceive an instrument whose very concept takes into account all the specific constraints of the Solar Orbiter.

In this article, we discuss possible coronagraph concepts adapted to Solar Orbiter constraints. These solutions are compared between them in terms of technical aspects as well as scientific aspects (by using a 3D-simulation of the solar corona developed at LAM).

P.61 Experimental devices and observations of the total solar eclipse at Kastellorizo, Greece

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The total solar eclipse of March 29 2006 was observed from Kastellorizo, Greece using, (a) a self constructed monochromatic Lyot filter, tuned at the Fe XIV 5303 Ǻ, with a 4 Ǻ bandwidth, (b) a self constructed spectrograph and (c) conventional photographic equipment. The Lyot filter was constructed from first principles, using off the bench components. A short description of the construction is presented. The active regions of the solar corona were observed with the above filter and their distribution along the solar rim is presented. The flash spectrum, lasting a few seconds before totality, was observed with the above mentioned spectrograph. Spectral analysis revealed a series of emission lines in the solar atmosphere, which have been identified with distinct chemical elements. The observed spectra are presented, after removing the corresponding continuum spectrum of the Sun. Finally several high quality photographs, taken at white light, are displayed.

P.62 Dynamic, nanoflare heating within a multi-strand, atmospheric loop structure

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Magnetic plasma loops have been termed the building blocks of the solar atmosphere. However, it must be recognised that if the range of loop structures we can observe do consist of many "sub-resolution" elements, then current one-dimensional hydrodynamic models are really only applicable to an individual plasma element or *strand*. Thus a loop should be viewed is an amalgamation of these strands. They could operate in thermal isolation from one another with a wide range of temperatures occurring across the structural elements. This scenario could occur when the energy release mechanism consists of localised, discrete bursts of energy that are due to small scale reconnection sites within the coronal magnetic field- the nanoflare coronal heating mechanism. These energy bursts occur in a time-dependent manner, distributed along the loop/strand length, giving a heating function that depends on space and time.

An analytical approach to how the solar plasma evolves in response to being heated rapidly (shorter than the cooling time) by a nanoflare-type energy release has already been developed (Cargill & Klimchuk 1997, 2004). The advantage of this analytical approach is that it can simulate the evolution of many thousands of strands with relative ease and calculate "global loop" observables such as the filling factor and emission measure. However, the disadvantages are that the "loop" is reduced to a single point and that the important effects of gravitational stratification and the energy and mass carried away by proper field-aligned flows are ignored.

Such modelling needs nanoflare heating that considers properly the thermal evolution of many strands together. Here we present results where, by using a fully HD model of multiple strands followed by the calculation of various instrument observables, we investigate how a "global" loop evolves under these heating conditions. Thus this research is the natural extension of the semi-analytical approach outlined above. Particular emphasis will be placed on the case when these energy bursts are occurring predominantly near the “loop” base.

P.63 A High Energy Telescope with Neutron Detection Capabilities (HETn) for Solar Orbiter

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The High Energy Telescope with neutron detection capabilities (HETn) on Solar Orbiter will detect and resolve protons and heavy ions and isotopes from 5 - 100 MeV/nuc, electrons from 0.3 to 20 MeV, positrons from 0.3 to 1 MeV, neutrons from 1 to 30 MeV, and gamma rays from 0.1 to 5 MeV. It consists of a set of angle detecting inclined sensors (ADIS) telescopes using a joint calorimeter for total energy and gamma ray measurement and a plastic scintillator for neutron detection. HETn will open a new window on energetic eruptive events on the Sun with its neutron detecting capability and allow determination of high-energy particle flux anisotropies during beamed events close to the Sun. Timing information on neutral particles (neutrons and gamma rays), on relativistic electrons and high-energy heavy ions will provide new insights into the processes which accelerate particles to high energies at the Sun and into transport processes between the source and the spacecraft in the near-Sun environment.

P.64 Solar Corona Polarimetry with Liquid Crystals: tests and application

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We present preliminary results of a study for the application of Liquid Crystals Variable Retarder (LCVR) plates to an imaging polarimeter for the study of the solar K-corona. The use of LCVR plates allows to replace mechanically rotating retarders of a polarimeter with electrically controlled devices, without having moving parts, making it advantageous for space-born coronagraphic applications. The polarimeter concept is based on a LCVR and a quarter wave plate are aligned in series along the polarimeter optical axis. The fast axis of one retarder is oriented at 45deg to the slow axis of the second. They are followed by a linear polarizer acting as the analyzer. This system is very compact and it can be integrated directly in front of a CCD camera, resulting in a very light-weight, miniaturized, broadband polarimeter.

P.65 A need for automated tools for extraction and visualisation of the data from Orbiter payload

V. Zharkova
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I would share our experiences in the automated feature recognition and classification in Solar Feature Catalogues. I also discuss how these techniques can be adjusted and expanded for the Orbiter payload and for the future data storage and visualisation for the solar community.

P.66 Statistical properties of hard X-ray and H-alpha flares and their link with the global solar activity

V. Zharkova and S. Zharkov
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We present the statistical analysis of H-alpha and hard X-ray flares in the cycle 23 and their links with sunspots and active regions from Solar Feature Catalogues. Flare occurrences are investigated for different latitudes and longitudes and compared with the global solar activity. Hard H-ray and gamma ray spectral indices are also investigated in relation with the global activity properties.

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