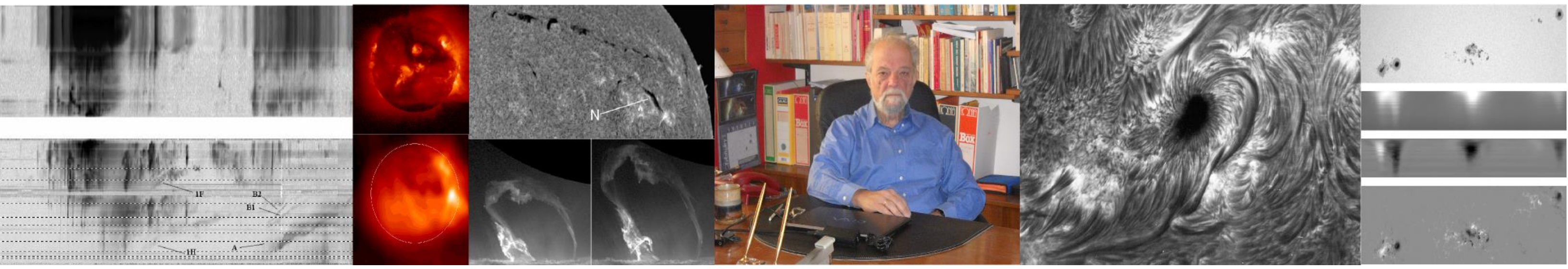

Multi-Wavelength Studies of the Solar Atmosphere: Celebrating the Career of Costas Alissandrakis

September 21–24 2015, Ioannina, Greece

Abstract and Programme Book

International Solar Physics Conference

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Program

Monday, September 21 2015

08:00 – 09:00	**Registration**	

Chair: Loukas Vlahos

09:00 – 09:30	Opening	(short speeches by the Rector of the University of Ioannina, the Dean of the School of Sciences, the chairman of the Physics Department and the director of the Section of Astrogeophysics)

Session I: Quiet Sun and Coronal Heating

09:30 – 10:15	G. Tsiropoula:	Structure and Dynamics of the Quiet Solar Photosphere and Chromosphere (*invited*)
10:15 – 10:45	S. Koutchmy:	From Solar Spicules to Soft X-ray Jets

10:45 – 11:15	Coffee break	

Chair: Jean-Claude Vial

11:15 – 11:35	C. Gontikakis:	Study of Plasma Flows Along Loops and the Inclination of Coronal Loops Using Data from SOHO/SUMER and Hinode/EIS
11:35 – 12:20	E. Buchlin:	Coronal Heating (*invited*)
12:20 – 12:40	L. Vlahos:	A Fermi Model for Coronal Heating by MHD Waves and Nanoflares
12:40 – 13:00	K. Moraitis:	A Data-driven Kinetic Approach to Nanoflare Coronal Heating

13:00 – 15:00	Lunch break	

Chair: Hongqi Zhang

Session I: Quiet Sun and Coronal Heating (continued)

15:00 – 15:20	S. Patsourakos:	Using Umbral Brightenings to Gauge the Properties of Coronal Heating

Session II: Magnetic Fields

15:20 – 16:05	M. Georgoulis:	Inferring the Nature and Properties of the Unknown Three-Dimensional Magnetic Field Above the Solar Photosphere (*invited*)

16:05 – 16:35	Coffee break	

Chair: Vladimir M. Bogod

16:35 – 17:20	D. E. Gary:	Mapping the 3D Coronal Magnetic Field and Temperature Structure Using Radio Techniques (*invited*)
17:20 – 18:05	G. Valori:	Magnetic Field Extrapolations (*invited*)

Tuesday, September 22 2015

Chair: Dale E. Gary

Session III: Active Regions

09:00 – 09:45	L. van Driel-Gesztelyi:	Multi-wavelength Observations of Active Regions (*invited*)
09:45 – 10:30	V. M. Bogod:	Active Region Studies Using Wideband Microwave Observations (*invited*)

10:30 – 11:00 Coffee break

Chair: Spiro Antiochos

11:00 – 11:45	V. Archontis:	Magnetic Flux Emergence and Associated Dynamic Events (*invited*)
11:45 – 12:05	I. Poljančić-Beljan:	Determination of the Kanzelhöhe Sunspot Group Positions: Manual versus Automatic Method

Session IV: Flares and Coronal Mass Ejections

12:05 – 12:50	B. Schmieder:	Observations of Flares (*invited*)

12:50 – 15:00 Lunch break

Chair: Kanaris Tsinganos

Session IV: Flares and Coronal Mass Ejections (continued)

15:00 – 15:45	A. V. Stepanov:	Quasi-periodic Pulsations and Flaring Plasma Diagnostics (*invited*)
15:45 – 16:05	A. Nindos:	A Tiny Event Producing an Interplanetary Type III Burst

16:05 – 16:35 Coffee break

Chair: Serge Koutchmy

16:35 – 17:20	A. Vourlidas:	The True Nature of Coronal Mass Ejections as Revealed from Multi-wavelength Observations (*invited*)
17:20 – 18:05	S. Antiochos:	The Origin of CMEs/Eruptive Flares (*invited*)

Wednesday, September 23 2015

Chair: Karl-Ludwig Klein

Session IV: Flares and Coronal Mass Ejections (continued)

09:00 – 09:45	J.-C. Vial:	Some Recent Developments on Solar Prominences (*invited*)
09:45 – 10:30	B. Vršnak:	Observations and Modeling of Shocks (*invited*)

10:30 – 11:00 Coffee break

Chair: Franca Drago

11:00 – 11:20	E. Nikou:	Spatial Correlation of Solar Flares and Coronal Mass Ejections
11:20 – 11:40	P. Syntelis:	Spectroscopic Observations of the Pre-eruptive Configuration Prior to the Ejection of Two CMEs from Active Region NOAA 11429
11:40 – 12:00	E. Liokati:	The Role of the Background Magnetic Field in the Major Eruptions of AR 11429
12:00 – 12:20	M. Pick:	Build-up of Coronal Mass Ejections and Associated Shocks in a Complex Environment
12:20 – 12:40	A. Anastasiadis:	Statistical Characteristics of Solar Energetic Particle Events
12:40 – 13:00	A. Kouloumvakos:	Properties of Solar Energetic Particle Events Inferred from their Associated Radio Emission

13:00 – 15:00 Lunch break

Chair: Monique Pick

Session V: Instruments

15:00 – 15:30	B. Schmieder:	Optical Instruments for Solar Physics in 2015 (*invited*)
15:30 – 16:00	K. Tsinganos:	The ASPIICS Coronagraph (*invited*)

16:00 – 16:30 Coffee break

Chair: Alexander Stepanov

16:30 – 17:00	H. Zhang:	Recent and Forthcoming Developments in the Instruments and Observing Researches at the Huairou Solar Observatory (*invited*)
17:00 – 17:30	V. M. Bogod:	RATAN-600 as Instrument for Solar Corona Studies (*invited*)
17:30 – 18:00	D. E. Gary:	Radio Observations with the Expanded Owens Valley Solar Array (EOVSA) (*invited*)

21:00 – ...: **Conference dinner**

Thursday, September 24 2015

Chair: Brigitte Schmieder

Session V: Instruments (continued)

09:00 – 09:30	K.-L. Klein:	The Nançay Radioheliograph (*invited*)
09:30 – 10:00	Y. Yan:	The Chinese Spectral Radioheliograph (*invited*)
10:00 – 10:30	A. Hillaris:	Twenty Years of the Solar Radiospectrograph ARTEMIS-IV

10:30 – 11:00 Coffee break

Chair:Yihua Yan

11:00 – 11:30	S. Wedemeyer:	Solar Observations with ALMA (*invited*)
11:30 – 12:00	Y. Zouganelis:	Solar Orbiter – Exploring the Sun-Heliosphere Connection (*invited*)

Session VI: Memories of working with Costas Alissandrakis

12:00 – 12:15 M. Pick
12:15 – 12:30 G. Tsiropoula
12:30 – 12:45 P. Preka-Papadema
12:45 – 13:00 F. Drago

13:00 – 15:00 Lunch break

Chair: Anastasios Anastasiadis

Session VI: Memories of working with Costas Alissandrakis (continued)

15:00 – 15:15 S. Koutchmy
15:15 – 15:30 V. M. Bogod
15:30 – 15:45 A. Hillaris
15:45 – 16:00 C. Gontikakis

16:00 – 16:30 Coffee break

Chair: Manolis Georgoulis

16:30 – 16:45	A. Nindos
16:45 – 17:00	S. Patsourakos
17:00 – 17:15	K.-L Klein
17:15 – 18:00	**Concluding remarks by Costas Alissandrakis**

Oral Presentations

Monday, September 21 2015

Structure and dynamics of the Quiet Solar Photosphere and Chromosphere *(invited)*

G. Tsiropoula

Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing (IAASARS), National Observatory of Athens, 15236 Penteli, Greece

The quiet solar photosphere and chromosphere are highly dynamic layers that exhibit inhomogeneities on different temporal and spatial scales. At the photosphere the magnetized solar plasma is organized from granules to supergranules and giant cells. These hierarchical cellular patterns are a visible manifestation of sub-photospheric convection flows which contribute substantially to the outward transport of energy from the deeper layers, thus maintaining the energy balance of the Sun as a whole. At the intergranular lanes bright points, best seen in the G-band, denote the presence of strong magnetic field concentrations, while vortex flows convectively driven and predicted by theory became recently visible at the granulation downdrafts thanks to high spatial resolution observations. The driving of foot-points of the small-scale magnetic fields on the surface of the Sun plays a fundamental role in sustaining the chromospheric network and leads to the build up of currents and/or the generation of waves, mechanisms considered as potential sources of energy. Chromospheric plasma, especially when seen in the center of the H line, is very clearly organized along fine-scale, dark, elongated structures that span out from regions of enhanced magnetic flux. Such filamentary structures portray the magnetic field topology and are consistent with the increasing dominance of the magnetic pressure over the gas pressure with increasing heights in the atmosphere. In this review we will attempt to present a comprehensive, although not complete, overview of our current knowledge on the structure and dynamics of the solar quiet photosphere and chromosphere based on high resolution observations both from the ground and from space, and the on-going improvement of non-LTE codes and 3D numerical simulations.

From Solar Spicules to SXR jets

S. Koutchmy

Institut d' Astrophysique de Paris – CNRS and Sorbonne University (UPMC), Paris, France

Some confusion exists when the spiky short live structure of the inner solar atmosphere is considered and this presentation will not be an exception. They are fascinating objects that strike our imagination. We will nonetheless attempt to make some “order” in the presentation- analysis of spicules, macro- spicules, small prominence turbulent limb events, TR bright limb EUV events, SXR jet events and spiky W-L energetic jets that reflect the guiding influence of the small scale magnetic field and its fast variations. These highly dynamic processes are thought to possibly be of relevance to the heating processes with emphasis on the temperature, magnetic field and height “fractionation” of the solar plasma with a noticeable contribution from C. Alissandrakis. The latest data- processed observations from Space (SOT of Hinode; AIA of SDO; IRIS; Solar-C) will also be used. A few movies will be demonstrated if time permits.

Study of plasma flows along loops and the inclination of coronal loops using data from SOHO/SUMER and Hinode/EIS

C. Gontikakis[1], C. E. Alissandrakis[2]

[1]Research Center for Astronomy and Applied Mathematics, Academy of Athens, Athens, Greece

[2]Section of Astro-Geophysics, Department of Physics, University of Ioannina, 45110 Ioannina, Greece

An important topic of coronal physics is the measure of the real inclination of coronal loops relative to the solar surface as well as the knowledge of plasma flows along them. We were able to measure plasma flows along loops together with the inclination of coronal loops by applying a simple geometrical model. The model needs as inputs the shape of loops traced in the intensity image, of a given spectral line together with the Dopplershifts measured in the same spectral line along the loop shape. Such data are produced with spectrographs as CDS and SUMER which operated on board SOHO or EIS aboard Hinode. We report loops having unidirectional flows as well as flows from the loop top towards the footpoints. We also report on different flow behavior according to the formation temperature of the recorded spectral lines. Moreover, we compare the loop inclination with the shape of the computed magnetic field lines.

Coronal heating *(invited)*

E. Buchlin

Institut d’ Astrophysique Spatiale, Bâtiment 121, CNRS/Université Paris-Sud, F-91405 Orsay cedex, France

The solar corona is maintained at temperatures of more than a million kelvins; such a hot plasma experiences substantial energy losses (300 to $10000 \mathrm{W/m^2}$), which must be compensated by heating. However, the details of heating mechanisms remain unclear, due to the complexity of the chromosphere-corona system and of the chain of processes leading from heating to observable quantities. Progress on the subject relies on comparing multi-wavelength observations of the corona with observable quantities produced by models, looking for unequivocal observable signatures of heating processes.

A Fermi model for Coronal Heating by MHD Waves and Nanoflares

L. Vlahos[1], Th. Pisokas[1], V. Tsiolis[1], S. Kovaios[1], H. Isliker[1] and A. Anastasiadis[2]

[1]Section of Astrophysics, Astronomy and Mechanics, Department of Physics, Aristotle University of Thessaloniki, 52124 Thessaloniki, Greece
[2]Institute for Astronomy, Astrophysics, Space Applications and Remote Sensing, National Observatory of Athens, 15236 Penteli, Greece

We analyze the main concepts of the 2nd order and the 1st order Fermi acceleration in an environment of current sheets. In particular, we study how test particles behave inside a small collection of scattering centers (magnetic clouds moving with Alfven speed). We study the energy gain of individual particles, the mean square displacement of a collection of particles, the diffusion coefficients, their energy distribution when they escape from the acceleration volume and the distribution of their escape times. We use all these information to compare the analytical and numerical estimate of the heating and acceleration of electrons and ions in weakly and strongly turbulent environment.

A data-driven kinetic approach to nanoflare coronal heating

K. Moraitis[1], A. Toutountzi[2], L. Vlahos[2], H. Isliker[2], M. K. Georgoulis[1], G. Chintzoglou[3]

[1]Research Center for Astronomy and Applied Mathematics (RCAAM), Academy of Athens, 11527 Athens, Greece
[2]Section of Astrophysics, Astronomy and Mechanics, Department of Physics, Aristotle University of Thessaloniki, 52124 Thessaloniki, Greece
[3]Department of Physics and Astronomy, George Mason University, USA

We investigate a nanoflare coronal heating scenario where the plasma is heated by highly localized electric fields that are fractally distributed throughout all space on and above the solar photosphere. The necessary ingredients of the model are obtained from a well-studied solar active region after reconstructing its three-dimensional magnetic field through non-linear force-free extrapolation and identifying the regions prone to releasing energy, the 'unstable volumes', through thresholding the magnitude of the electrical current. Using standard clustering techniques and assuming a simple model for the resistivity, we estimate the statistical distribution of the size and of the magnitude of the electric field of the unstable volumes, as well as their fractal dimension. These allow us to follow the evolution of a large number of initially thermal particles as they heat and accelerate in this complex environment and also to deduce the range of parameters needed in coronal heating. This research has been co-financed by the European Union (European Social Fund – ESF) and Greek national funds through the Operational Program "Education and Lifelong Learning" of the National Strategic Reference Framework (NSRF) - Research Funding Program: Thales. Investing in knowledge society through the European Social Fund.

Using Umbral Brightenings to Gauge the Properties of Coronal Heating

C. Alissandrakis, **S. Patsourakos**

Section of Astrogeophysics, Department of Physics, University of Ioannina, 45110 Ioannina, Greece

Observations of the footpoints of coronal loops can supply important information regarding the properties of coronal heating. This is because they correspond to the thin transition segments of loops, which respond very sensitively to changes of the coronal pressure and heating. However, a significant obstacle in unambiguously observing coronal loop footpoints is posed by low-lying background structures which prevent "clean" views of the footpoints. This limitation is largely mitigated when observing coronal loops rooted in sunspots, where the coronal background emission is low. We hereby present detailed multi-wavelength observations of umbral brightenings recorded by AIA on SDO. The brightenings were associated with the activation of transient coronal loops which seemingly undergo cooling all way from hot down to warm AIA channels. We discuss the temporal characteristics of the observed umbral brightenings as well as the coronal/footpoint intensity ratio in view of coronal loop models.

Inferring the Nature and Properties of the Unknown Three - Dimensional Magnetic Field Above the Solar Photosphere *(invited)*

M. K. Georgoulis

Research Center for Astronomy and Applied Mathematics (RCAAM), Academy of Athens, 11527 Athens, Greece

The limited quantitative knowledge of the solar magnetic field only in the photospheric level is a major setback for an array of studies of solar activity. The seminal work of C. E. Alissandrakis in 1981 enabled an unparalleled speedy assessment of the unknown coronal magnetic field at acceptable quality using as boundary condition the normal or vector components of photospheric magnetism. Relying on the magnetostatic, zero-beta force-free approximation, this assessment allowed for both calculating the current-free (i.e., potential) magnetic energy and some current-carrying (i.e., free) energy on top of it, thus facilitating a class of studies of solar eruptive activity. While the 'Alissandrakis method' and subsequent variations was used widely for more than two decades, virtually every work relying on it underlined what was thought to be its major caveat: its linearity and non-uniqueness, that should have an impact on the realism of its solution, given the strongly nonlinear (let alone non-force-free) photosphere. With nonlinear force-free extrapolations being now the norm, we aim to examine how far off the conventional linear force-free solution is, in terms of morphology, free magnetic energy, and relative magnetic helicity. We also look into some surprisingly little known property of the linear force-free solution that, also subject to non-uniqueness issues, may nonetheless provide extremely fast forced (i.e., non-force-free) solutions for the coronal magnetic field. In conclusion, we subscribe that there may be more uses for the pioneering 'Alissandrakis method' than was initially judged in a rather over-simplified manner.

Mapping the 3D coronal magnetic field and temperature structure using radio techniques *(invited)*

D. E. Gary, G. D. Fleishman, G. M. Nita and Z. Wang

New Jersey Institute of Technology, Newark, USA

Solar radio emission is highly dependent on the magnetic field strength and direction in the corona, and at the same time provides a direct measure of electron temperature/energy. A variety of radiation mechanisms contribute to the emission, each with their own dependencies, and which mechanism dominates in a particular circumstance is determined by electron energetics, magnetic field strength and direction, and density. The key to accessing the inherent diagnostic power of radio emission is to have multi-frequency radio images of sufficient quality, resolution, and polarization purity, with which to confidently identify and separate the different emission mechanisms, to remove the ambiguities that have limited many past radio studies. The technical challenge of obtaining high-quality, multi-frequency images is being addressed for the first time by a number of new radio instruments such as EOVSA, JVLA, CSRH, USSRT, and FASR, each of which are designed specifically for this purpose. This report emphasizes one of the more important applications—determining the three-dimensional coronal magnetic field and temperature structure of solar active regions. We illustrate the talk with new and accurate 3D modeling of radio emission and radiative transfer, based on the nonlinear force-free field extrapolation of vector magnetic field measurements, and describe the potent combination of new observations with forward fitting tools in development.

Magnetic Field Extrapolations *(invited)*

G. Valori

University College London, Mullard Space Science Laboratory, UK

The extrapolation of photospheric measurements is the only method currently available to obtain a three-dimensional, high-resolution reconstruction of the coronal magnetic field. The extrapolation is performed under the assumption that the coronal field is force-free in the entire considered volume. In its linear formulation, the proportion between current density and magnetic field is the same on all field lines, and the field is determined by the photospheric values of its vertical component. Alissandrakis' solution of the linearised problem is being extensively used in the past three decades in a wide variety of applications. I will review few of the most recent ones showing the actuality and usefulness of that solution.

On the other hand, some applications require the modelling of largely potential fields with locally concentrated currents, which cannot be modelled by the linear approximation. In such cases, one has to solve numerically the nonlinear extrapolation problem, which, in turn, requires the use of the full vector magnetogram as boundary condition. I will show few cases of success and failure of such methods, and illustrate why we may get different results from different methods.

Tuesday, September 22 2015

Multiwavelength Observations of Active Regions *(invited)*

L. van Driel-Gesztelyi[1,2,3]

[1]Observatoire de Paris, LESIA, UMR 8109, France
[2]University College London, Mullard Space Science Laboratory, UK
[3]Konkoly Observatory, Budapest, Hungary

Solar active regions are the totality of observable phenomena in a 3D volume represented by the extension of magnetic field from the photosphere to corona, revealed by emissions over a wide range of wavelengths from radio to X-rays and gamma-rays (only during flares) accompanying the emergence of strong mildly twisted magnetic flux (kG, $> 10^{20}$ Mx) through the photosphere into the chromosphere and corona. The characteristic features of an evolving active region are markedly different at the photospheric, chromospheric, and coronal levels, which do not only represent different heights in the solar atmosphere, but also different temperatures and physical conditions reflected in a plasma beta decreasing with height. As only very limited information can be deduced from a single 2D information of a 3D object, a multi-temperature active region can only be understood by combining observations over a broad wavelength range. I will make an overview of the key findings at various wavelengths and present a synthesis.

Active Region Study Using Wideband Microwave Observations *(invited)*

V. M. Bogod

Special Astrophysical Observatory, Saint-Petersburg, Russia

The results of the solar radio emission study using the reflector-type radio telescope RATAN-600 are presented. It is mentioned the importance of using large radio telescopes for study of different stable solar plasma objects: from the small-scale structures up to bright sunspot associated sources, pre-flare and post-flare plasma in the active region. It is shown that the methods of multi-wavelength radioastronomy promising for the development of the coronal magnetometry methods, the study of height magnetic field structure above sunspots by means of multiwave stereoscopy. For free-free emission objects is used radio tomography method. For objects free-free emission methods work full-wave imaging. We discuss the current problems of solar physics at a large instrument in the range of 1-100 GHz. The results of regular multiwave observations for prediction of solar flares are presented.

Magnetic flux emergence and associated dynamic events *(invited)*

V. Archontis

School of Mathematics and Statistics, University of St. Andrews, UK

Magnetic flux emergence in the Sun is the physical process through which the magnetic

fields rise from the solar interior to the solar surface and above. Observations of the solar surface reveal that magnetic flux emerges over a range of different spatial and temporal scales: on small-scales to form the internetwork field and on large scales to build up active regions. The characteristic turnover time of small-scale flux emergence is only a few minutes while the lifetime of active regions may persist for up to days or several weeks. Therefore, one may naturally assume that the large-scale flux emergence is responsible for the most long-lived dynamic events in the Sun.
The purpose of this talk is to report on the progress that has been made 1) in exploring the nature of flux emergence on multiple scales and 2) in studying the coupling between flux emergence and dynamic phenomena at various atmospheric heights.

Determination of the Kanzelhöhe sunspot group positions: manual versus automatic method

I. Poljančić-Beljan[1], R. Jurdana – Šepić[1], R. Brajša[2], D. Hržina[3], W. Pötzi[4], A. Hanslmeier[5], D. Ruždjak[2], D. Sudar[2], I. Skokić[6], H. Wöhl[7]

[1]Physics Department, University of Rijeka, Croatia
[2]Hvar Observatory, Faculty of Geodesy, University of Zagreb, Zagreb, Croatia
[3]Zagreb Astronomical Observatory, Zagreb, Croatia
[4]Konzelhöhe Observatory for Solar and Enviromental Research, University of Graz, Austria
[5]Institute of Physics, IGAM, University of Graz, Graz, Austria
[6]Astronomical Institute of Czech Academy of Sciences, Ondejov Observatory, Czech Republic
[7]Kiepenheuer-Institut für Sonnenphysik, Freiburg, Germany

For the investigation of possible variations of the solar rotation, sunspots and sunspot groups are very often used as tracers, mainly because of the long term data sets available from various observatories. Until now, for the investigation of temporal variations of the solar rotation using sunspot groups as tracers, the Kanzelhöhe data set was analysed only for the period 1947-1981. Our aim is to provide a continuation of that previous investigation. For this reason we processed Kanzelhöhe sunspot drawings for solar cycles nos. 20 – 23 (manual method) and Kanzelhöhe white light images for solar cycle no. 24 (automatic method), covering almost the 41 year period, 1964 – 2015. When both methods for the heliographic positions determination have been used, it is important to compare them. Here we present the results of the manual versus automatic method comparison (differential rotation coefficients for both methods, differences in the identification of the sunspot groups, differences in the number of identified sunspot groups, etc.) performed for the year 2014.

Observations of Flares *(invited)*

B. Schmieder

Observatoire de Paris, LESIA, Meudon 92195, France

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Quasi-periodical pulsations and flarind plasma diagnostics *(invited)*

A. V. Stepanov

Pulkovo Observatory, Saint Petersburg, Russia

Two approaches in the interpretation of quasi-periodic pulsations in solar and stellar flares are presented. The first presents flaring loops as resonators for magneto-hydrodynamic (MHD) oscillations. Leaky and non-leaky modes are discussed. The second approach is based on Alfvén's idea of the flaring loop as an equivalent electric circuit. This approach naturally explains high-quality pulsations. It is shown that both approaches provide an efficient diagnostic tool for flare plasma on the Sun, red dwarfs, and in giant flares on neutron stars.

A Tiny Event Producing an Interplanetary Type III Burst

C. E. Alissandrakis[1], **A. Nindos**[1], S. Patsourakos[1], A. Kontogeorgos[2], P. Tsitsipis[2]

[1]Section of Astrogeophysics, Physics Department, University of Ioannina, 45110 Ioannina, Greece

[2]Technological Educational Institute of Lamia, 35100 Lamia, Greece

We investigate the conditions under which small-scale energy release events in the low corona gave rise to strong interplanetary (IP) type III bursts. We analyze observations of three tiny events, detected by the Nançay Radio Heliograph (NRH), two of which produced IP type IIIs. We took advantage of the NRH positioning information and of the high cadence of AIA/SDO data to identify the associated EUV emissions. We measured positions and time profiles of the metric and EUV sources. We found that the EUV events that produced IP type IIIs were located near a coronal hole boundary, while the one that did not was located in a closed magnetic field region. In all three cases tiny flaring loops were involved, without any associated mass eruption. In the best observed case the radio emission at the highest frequency (435 MHz) was displaced by $\sim 55''$ with respect to the small flaring loop. The metric type III emission shows a complex structure in space and in time, indicative of multiple electron beams, despite the low intensity of the events. From the combined analysis of dynamic spectra and NRH images we derived the electron beam velocity as well as the height, ambient plasma temperature and density at the level of formation of the 160 MHz emission. From the analysis of the differential emission measure derived from the AIA images we found that the first evidence of energy release was at the footpoints and this was followed by the development of flaring loops and subsequent cooling. We conclude that even small energy release events can accelerate enough electrons to give rise to powerful IP type III bursts. The proximity of the electron acceleration site to open magnetic field lines facilitates the escape of the electrons into the interplanetary space. The offset between the site of energy release and the metric type III location warrants further investigation.

The True Nature of Coronal Mass Ejections as Revealed from Multi-wavelength Observations *(invited)*

A. Vourlidas

The Johns Hopkins University Applied Physics Laboratory, Laurel, MD 2072, USA

In the last 20 years, the field of Solar Physics has undergone a renaissance due to the availability of high-resolution, high-cadence full Sun observations in the EUV and visible. We have realized that the solar corona is the seat of the Sun explosive activity manifested with daily expulsions of billions of tons of magnetized plasma in the form of magnetic flux ropes. These ejections, called Coronal Mass Ejections (CMEs), are the primary drivers of the variability of the terrestrial magnetosphere and outer atmosphere.

Tens of thousands of CMEs have been observed by numerous instruments and catalogued in a variety of ways. So, we must know a great deal about CMEs. In this talk, we review the state of CME knowledge and address several obvious questions: Where do we stand today? What are the open questions in CME research? Where are we going?

The Origin of CMEs/Eruptive Flares *(invited)*

S. K. Antiochos

Heliophysics Science Division, NASA Goddard Space Flight Center, Greenbelt, MD 20771, USA

Solar eruptive events (SEE), which consist of fast coronal mass ejections and intense flares, are the largest and most energetic form of solar activity, and are the drivers of the most destructive space weather throughout interplanetary space. Understanding the physical origin of these giant magnetic explosions is absolutely essential for any first-principles modeling of space weather. Furthermore, these well-observed events offer the best opportunity to study the fundamental physics of magnetic field and plasma interactions; in particular, the key processes of magnetic reconnection and particle acceleration. We describe how magnetic reconnection is responsible for the energy buildup that leads to SEEs, how it drives the explosive energy release, and how it controls the propagation of the event. Reconnection turns out to be especially important for understanding the escape of high-energy particles into the heliosphere. A key issue for numerical simulation of SEEs is the effect of the resistivity model used by the simulation, because the onset and subsequent development of reconnection inherently dependent on the effective resistivity. We present the latest ultra-high numerical resolution 2.5D simulations quantifying how the reconnection dynamics scale with effective resistivity. We also present 3D simulations demonstrating the complexities introduced by reconnection in a realistic 3D system. The implications of our results for interpreting observations and for developing space weather capabilities will be described.

This work was supported by the NASA LWS and SR Programs.

Wednesday, September 23 2015

Some recent developments on Solar Prominences *(invited)*

J.-C. Vial[1], O. Engvold[2]

[1]Institut d' Astrophysique Spatiale, Université Paris-Sud & C.N.R.S., 91405 Orsay, France
[2]University of Oslo, Institute of Theoretical Astrophysics, Blindern, Oslo, Norway

Much work has been recently devoted to solar prominences in all their various states (quiescent, active, eruptive, ...) and their association with flares and coronal mass ejections. The most recent reviews include Living Reviews in solar physics (Parenti, 2014), the proceedings of IAUS 300 (eds. Schmieder, Malherbe and Wu, 2014) and the book "Solar Prominences" (eds. Vial & Engvold, 2015). Keeping in mind some properties well established in these works, we will focus on the most recent developments, in all areas related to prominences (morphology, diagnostic, dynamics, magnetic evolution, formation and eruption, ..) taking into account the most recent observational and modeling results, with some emphasis on the IRIS data.

Obsrvations and Modeling of Shocks *(invited)*

B. Vršnak, T. Žic

Hvar Observatory, Faculty of Geodesy, Kaciceva 26, HR-10000 Zagreb, Croatia

Explosive expansion of coronal structures associated with CME/flare eruptions creates large-scale large-amplitude waves and shocks in the solar corona, usually observed as EUV coronal waves, chromospheric Moreton waves, type II radio bursts, and sharp fronts in coronagraphic images of CMEs. Regarding the low-coronal signatures of such disturbances (EUV waves), the most favorable initiation process is impulsive lateral expansion of CME flanks at the early phase of the eruption. In theoretical sense, this means that an accelerating 2.5-D piston creates a large-amplitude magnetosonic wavefront, which steepens into a shock due to a nonlinear evolution of the wave. In the formation phase the wave amplitude increases, the leading edge sharpens, and the phase-velocity increases. After the lateral expansion of the CME stops, the disturbance continues to move as a freely propagating simple-wave: the wave profile broadens, the amplitude decreases, phase-speed decreases, and a propagating rarefaction region forms in the wake of the wavefront. The formation of the disturbance segments closer to the nose of the erupting arcade is similar to that at its flanks, and it results in excitation of type II radio burst and appearance of bright front in EUV filtergrams and white-light coronagraphic images. These forehead wave segments stay continuously driven by the eruption and can survive all the way to 1 AU and beyond. A very favorable condition for long-distance propagation of the shock is the decreasing ambient density and magnetosonic speed, resulting in an increase of the wave amplitude and Mach number. Finally, it is illustrated how the observational/theoretical analysis of the evolution of coronal waves and shocks can be applied for diagnostics of the solar atmosphere.
This work has been fully supported by Croatian Science Foundation under the project 6212 "Solar and Stellar Variability".

Spatial correlation of solar flares and coronal mass ejections

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In order to quantify the spatial relationship between pairs of solar flares and coronal mass ejections (CMEs) we used 19 events that were associated with both solar flares and CMEs. To achieve our goal we used images at 174 Å from the Sun Watcher using APS and Image Processing (SWAP) instrument aboard Project for On-Board Autonomy-2 (PROBA-2) satellite. Those data are ideal for that kind of study because flare emission does not saturate much. To prevent additional saturation we avoided using events that were related to M-class or X-class flares. We chose eruptions that occurred close to the disk center, as viewed from Earth, while they were observed as limb events by the EUV Imagers (EUVI) aboard the Solar TErrestrial RElations Observatory (STEREO). Images at 195 Å from the EUVI instruments were used to determine the CME initiation time. Proxies for the CME source locations were the centroids of the CME-associated EUV dimmings, while proxies for the flare locations were the centroids of the flare brightenings. For each event we compared the location of the dimmings with the location of the flare brightenings' centroid and we found out that in 5 events the CME location was cospatial with the flare brightenings. The distances between each pair of flare-CME locations ranged from 12.5 Mm to 137.2 Mm with a median value of 49.7 Mm. We also examined the evolution of the surface of the dimmings over time and noticed that its decay phase is more gradual than that of the corresponding X-ray flux. We also studied the CME source locations with respect to the underlying photospheric magnetic field using magnetograms from the Helioseismic and Magnetic Imager (HMI) aboard Solar Dynamics Observatory (SDO) and noted that in 8 cases the location of the CME was above the neutral line of the magnetic field.

Spectroscopic observations of the pre-eruptive configuration prior to the ejection of two CMEs from Active Region NOAA 11429

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We present a spectroscopic analysis of the pre-eruptive configuration of active region (AR) NOAA 11429, prior to the ejection of two Coronal Mass Ejections (CMEs) on March 7, 2012. We study the thermal components and the dynamics associated with the ejected flux ropes. We perform a Differential Emission Measure (DEM) analysis using Hinode/EIS and AIA/SDO observations to identify the emission components of the active region associated with the flux ropes. We studied separately the East and West part of the active region, from which two different CMEs originate during two X-class flares. We

identified a high temperature ($\log T = 6.87.1$) flux rope emission component in both the East and West part of the AR. The time evolution of the East region showed increase of the mean DEM in this temperature region by an order of magnitude 5 hours prior to the first CME ejection. We associated this emission increase with a gradual expansion of the flux rope (blueshifts around $\approx$ 20 kms) and gradual heating (increased non-thermal velocities in Ca XI $\sim$ 200.97Å). Using the ratio of Ca XI $\sim$ 181.90Å over Ca XI $\sim$200.97Å, we measure an electron density of $7 \times 10^9 - 6 \times 10^{10}$ cm^{-3}. We argue that the ejection of the CME from the East part triggered the CME from the West part of active region.

The Role of the Background Magnetic Field in the Major Eruptions of AR 11429

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It is believed that the background overlying magnetic field of active regions tends to inhibit global eruptions. This conjecture is checked against observations of two major coronal mass ejections (CMEs) that occurred in active region AR 11429 during early 7 March 2012. We studied the long-term evolution of the active region's background magnetic field using line of sight (LOS) magnetograms obtained with the Helioseismic and Magnetic Imager (HMI) aboard the Solar Dynamics Observatory (SDO). The source regions of the two CMEs were determined using EUV images obtained with the Atmospheric Imaging Assembly aboard SDO. Using potential magnetic field extrapolations, we calculated both average values and maps of the decay index, $n = -(z/\mathrm{B})(\partial \mathrm{B}/\partial z)$, of the magnetic field B (i.e. how fast the field decreases with height, z) related to each event for an interval of about 48 hours that was roughly centered around the initiation times of the two eruptions. Our results indicate that the temporal variation of the decay index is small.

Build-up of Coronal Mass Ejections and Associated Shocks in a Complex Environment

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Because of the lack of imaging radio observations, there are still to-day a very small number of cases for which EUV, or X-ray, and radio imaging observations are available in order to study CMEs and shocks development. The aim of this presentation is to contribute to the understanding of how the environment affects the development of the CMEs, the formation of shocks and their propagation. We have studied the interactions of the CMEs with the ambient structures as they develop in the low, middle and high corona. We choose events which present a radically different direction of propagation observed by SOHO in the high corona with the one observed in the low corona with SDO. All these events were also observed by the Nanay Radio-heliograph. I shall recall the contribution of Prof. C. Alissandrakis and his colleagues on the general topics of these studies. I shall

discuss the physical implications of this analysis and also its present limitations due, in particular to a limited imaging radio frequency range coverage.

Statistical characteristics of Solar Energetic Particle Events

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Energetic processes on the Sun accelerate protons to GeV and electrons to tens of MeV, leading to Solar Energetic Particle (SEP) events. Such events are typically divided into two basic classes, the so-called "gradual" and the "impulsive" ones. Impulsive SEP events are associated with short timescales and are attributed to solar flares (SFs). Gradual events are associated with longer timescales, coronal and interplanetary shocks and are associated to coronal mass ejections (CMEs). In this work the properties and associations of 314 SEP events occurred during the years 1984 to 2013 have been examined. As a result, the systematic presence of the socalled hybrid or mixed events in the vast majority of our catalogue was confirmed. This suggests that both SFs and CMEs have a prevalent role in the generation, acceleration and propagation of SEP events. In addition, a mapping of the peak proton flux on various pairs of the parent solar source characteristics was applied in order to illustrate the expected correlations in 3-D space. This mapping further demonstrated that gradual SEP events that stem from the central part of the visible solar disk are increasingly important and constitute a significant radiation risk. The present work was performed in the framework of the ESA Contract No 4000109641/13/NL/AK and the PROTEAS project, within the KRIPIS action of the General Secretariat of Research and Technology, funded by Greece and the European Regional Development Fund of the European Union under the O.P. Competitiveness and Entrepreneurship, NSRF 2007-2013 and the Regional Operational Program of Attica.

Properties of Solar Energetic Particle Events Inferred from their Associated Radio Emission

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We study selected properties of Solar Energetic Particle (SEP) events as inferred from their associated radio emissions. We used a catalogue of 115 SEP events that consists of entries of proton intensity enhancements at one AU, with complete coverage over solar cycle 23, based on high-energy ($\sim$ 68 MeV) protons from SOHO/ERNE and we calculated the proton release time at the Sun using velocity dispersion analysis (VDA). After an initial rejection of cases with unrealistic VDA path lengths, we assembled composite radio spectra for the remaining events using data from ground-based and space-borne radio-spectrographs. For every event we registered the associated radio emissions and we divided the events in groups according to their associated radio emissions. The proton release was found to be most often accompanied by both type III and II radio bursts, but a good association percentage was also registered in cases accompanied by type IIIs only. The worst association was found for the cases with type II only association. These radio association percentages support the idea that both flare- and shock-resident particle release processes are observed in high-energy proton events. In cases of type III-associated events we extended our study to the timings between the type III radio emission, the proton release, and the electron release as inferred from VDA based on Wind/3DP 20-646 keV data. Typically, the protons are released after the start of the associated type III bursts and simultaneously or before the release of energetic electrons. For the cases with type II radio association we found that the distribution of the proton release heights had a maximum at $\sim$ 2.5 Rs. Most (69%) of the flares associated to our SEP events were located at the western hemisphere, with a peak within the well-connected region of 50-60 deg western longitude.

Optical Instruments for Solar Physics in 2015 *(invited)*

B. Schmieder

Observatoire de Paris, LESIA, Meudon 92195, France

I will not make an exhaustive review of all the telescopes over the world in all the solar observatories. I will concentrate on a few telescopes recently in operation (the NVST in Fuxian lake, the GREGOR in Tenerife). I plan to emphasize on their first results. I will also present some post focus instrumentation which has no concurrence in space (spectropolarimetry of prominences with THEMIS, high spatial and spectral resolution with the SST). Besides, I will also present the global survey of the Sun i.e. GONG Halpha and magnetographs of the full Sun, the Japonese SMART...
What about the future large telescopes? I will give a few informations on the status of the telescopes in US (DKIST), in Europe, in China, in India.

The ASPIICS Coronagraph *(invited)*

K. Tsinganos[1,2]

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Recent and forthcoming developments in the instruments and observing researches at the Huairou Solar Observatory *(invited)*

H. Zhang

National Astronomical Observatories, Chinese Academy of Sciences, Beijing, China

In this talk, I would like to introduce the recent and forthcoming developments in solar optical observing instruments for the measurements of solar magnetic fields at Huairou Solar Observing Station mainly, and also the relationship with some solar optical projects in China in the future.
I also present some of recently observing study of solar magnetic field, especially on the non-potentiality and helicity of solar active regions and the relationship with solar cycles at Huairou Solar Observing Station.

RATAN-600 as Instrument for Solar Corona Study *(invited)*

V. M. Bogod

Special Astrophysical Observatory, Saint-Petersburg, Russia

It is described the state of today's and opportunities of the large reflector-type radio telescope RATAN-600, which is regularly used for solar observations over a wide microwave band. It is presented the main methods of solar observations, recording, processing and presentation to the user using by web-server. The problems of improving the temporal and frequency characteristics of the radio telescope are discussed. Examples of using multi-wavelength observations to solar flares forecasting are presented.

Thursday, September 24 2015

The Nançay Radioheliograph *(invited)*

K.-L. Klein, A. Kerdraon

LESIA and Station de radioastronomie de Nançay, Observatoire de Paris, CNRS, Univ. Paris 6 & 7, 92195 Meudon, France

The Nançay Radioheliograph (NRH), located in central France, has been providing images of the solar corona at decimetre-to-metre wavelengths since 1996. It is widely used in multi-wavelength studies of the Sun, ranging from the quiet solar atmosphere to active and eruptive phenomena. The instrument has been out of operation in recent months for important upgrading work. Its future operation is supported to accompany the Solar Orbiter mission. This contribution will present an overview on the instrument's state and the availability of data from the NRH and the Nançay spectrographs (Decameter Array, ORFEES). Some recent results on the quiet Sun and eruptive activity will be presented, and the general use of the Nançay solar radio observations for astrophysical research and space weather services will be discussed.

The Chinese Spectral Radioheliograph *(invited)*

Y. Yan

National Astronomical Observatories, Chinese Academy of Sciences, Beijing 100012, China

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Twenty Years of the Solar Radiospectrograph ARTEMIS – IV

C. Caroubalos[1], C. E. Alissandrakis[2], **A. Hillaris**[3], P. Preka–Papadema[3], X. Moussas[3], A. Nindos[2], S. Patsourakos[2], A. Kontogeorgos[4], P. Tsitsipis[4], A. Kouloumvakos[2], C. Bouratzis[3]

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The Solar Radiospectrograph of the University of Athens is in operation at the Thermopylae Satellite Communication Station since 1996. The observations extend from the base of the Solar Corona (650 MHz) to about 2 Solar Radii (20 MHz) with time resolution 1/10-1/100 sec. The recordings in the form of dynamic spectra, measure radio flux as a function of height in the corona; our observations are combined with spatial data from the Nancay Radioheliograph (NRH) whenever the need for 3D positional information arises.

The ARTEMIS-IV contribution in the study of solar radio bursts includes:
– Investigation of fine structures in radio events due to high sampling rate; small scale features of radio bursts are thus analysed.

– Study of the association of solar bursts with interplanetary phenomena because of its extended frequency coverage which complements the WIND/WAVES receivers. The combined spectral data range from the base of the Solar Corona to the near Earth space.

– Examination of the radio signatures of solar energetic events, such as flares, CMEs and SEP events; the ARTEMIS-IV data are combined, in this case with GOES, SOHO/LASCO, STEREO/WAVES etc observations.

This report serves as a brief but comprehensive summation of this operation.

Solar observations with ALMA *(invited)*

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Institute of Theoretical Astrophysics, University of Oslo, Postboks 1029 Blindern, NO-0315 Oslo, Norway

The interferometric Atacama Large Millimeter/submillimeter Array (ALMA) has already demonstrated its impressive capabilities by observing a large variety of targets ranging from protoplanetary disks to galactic nuclei. ALMA is also capable of observing the Sun. The technically challenging solar observing modes are currently under development and regular observations are expected to begin in late 2016.
ALMA consists of 66 antennas located in the Chilean Andes at an altitude of 5000 m and is a true leap forward in terms of spatial resolution at millimeter wavelengths. The resolution of reconstructed interferometric images of the Sun is anticipated to be close to what current optical solar telescopes can achieve. In combination with the high temporal and spectral resolution, these new capabilities open up new parameter spaces for solar millimeter observations.
The solar radiation at wavelengths observed by ALMA originates from the chromosphere, where the height of the sampled layer increases with selected wavelength. The continuum intensity is linearly correlated to the local gas temperature in the probed layer, which makes ALMA essentially a linear thermometer. During flares, ALMA can detect additional non-thermal emission contributions. Measurements of the polarization state facilitate the valuable determination of the chromospheric magnetic field. In addition, spectrally resolved observations of radio recombination and molecular lines may yield great diagnostic potential, which has yet to be investigated and developed.
Many different scientific applications for a large range of targets from quiet Sun to active regions and prominences are possible, ranging from ultra-high cadence wave studies to flare observations. ALMA, in particular in combination with other ground-based and space-borne instruments, will certainly lead to fascinating new findings, which will advance our understanding of the atmosphere of our Sun. Here I give an overview of ALMA's capabilities and potential science cases.

Solar Orbiter - Exploring the Sun-Heliosphere Connection *(invited)*

Y. Zouganelis[1], D. Mueller[1], O. C. St Cyr[2], H. R. Gilbert[2]

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Solar Orbiter, the first mission of ESA's Cosmic Vision 2015-2025 programme, promises to deliver groundbreaking science with previously unavailable observational capabilities provided by a suite of in-situ and remote-sensing instruments in a unique orbit. The mission will address the central question of heliophysics: How does the Sun create and control the heliosphere? The heliosphere represents a uniquely accessible domain of space, where fundamental physical processes common to solar, astrophysical and laboratory plasmas can be studied under conditions impossible to reproduce on Earth and unfeasible to observe from astronomical distances. In this talk, we highlight the scientific goals of Solar Orbiter, address the synergy between this joint ESA/NASA mission and other new space- and ground-based observatories, and present the mission's development status.

Poster Presentations

Correlation between CME-related Solar Energetic Particle events at ACE and atmospheric weather: A statistical study (1997-2015)

G. Anagnostopoulos, S. A. Menesidou, A. Rigas

Space Research Laboratory, Department of Electrical and Computer Engineering, Democritus University of Thrace, Greece

The inuence of space weather on the Earths atmospheric weather and climate is an important scientic issue with great social interest. In this study we present, for the rst time, statistical results during times of 28 strong ICMEs observed between 1997 - May, 2015, which conrm a strong correlation between the solar activity and the temperature TM in north-east USA (Madison, Wisconsin). In particular we found that: (a) during a time period of 15 days (day=-7 to day=+7) centered on day D0 of ICMEs arrival at Earth, the temperature (TM) in Madison shows maximum values around (+/- 1 day) or after the day D0 in 89.2% of the cases examined, (b) the high (1880 - 4700 keV) energy solar proton (HESP) uxes, show a much stronger correlation with TM than the magnetospheric particles electrons, before the ICME arrival, (c) the total temperature increase by the day D0 is strongly ($r = 0.8, p < 0.001$) correlated with the time duration of the HESP events, (d) the temperature increase during the cases examined is very strongly and signicantly correlated with the HESP ux increase, within $\sim$ 1 day ($r = 0.9, p < 0.001$) (e) warm air ows from the southward direction mediates the link between HESP uxes and the temperature increase TM, and (f) the temperature increase TM during the HESP events shows an average rate of $\sim$ 2°C/day (28 events examined). We infer that the HESP events preceding the great ICMEs examined in this study strongly control the temperature TM in north-east USA during the "winter" times, via a fast ($\sim$ 1 day) process due to northward air ows from the Gulf Stream.

Artemis-IV Observations: Intermediate Drift Bursts at Mectric Wavelengths

C. Bouratzis[1], A. Hillaris[1], C. E. Alissandrakis[2], P. Preka–Papadema[1], X. Moussas[1], P. Tsitsipis[3], A. Kontogeorgos[3]

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Sixteen metric type-IV events with rich fine structure were observed by the ARTEMIS–IV/SAO high resolution (10 ms) receiver. We studied the intermediate drift bursts (fibers) embedded within these type-IV continua. The characteristic parameters examined were drift rate, instantaneous spectral width, duration at fixed frequency; furthermore we studied the periodic behaviour of fiber groups. On the ARTEMIS-IV dynamic spectra negative and positive drifting fibers were often recorded simultaneously; most were found to drifting towards the lower frequencies on dynamic spectra.

Artemis-IV Observations: NarrowBand Bursts at Mectric Wavelengths

C. Bouratzis[1], A. Hillaris[1], C. E. Alissandrakis[2], P. Preka–Papadema[1], X. Moussas[1], P. Tsitsipis[3], A. Kontogeorgos[3]

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We analyzed 27 metric typeIV events with embedded narrow-band bursts, observed by the ARTEMISIV radio spectrograph; these were recorded with the SAO high resolution (10 ms cadence) receiver of ARTEMIS-IV in the 270–450 MHz range. The morphological characteristics of isolated narrow-band structures (mostly spikes) and groups or chains of structures were studied. These included duration, spectral width, and frequency drift of individual narrow-band bursts, groups and chains and in one event (21 April 2003) we compared the position of spikes to that of the continuum emission using two dimensional data from the Nancay radioheliograph and with soft x-ray emission using GOES/SXI. Often spikes appear in chains, closely spaced in the time (column chains) or the frequency domain (row chains). Collumn chains have frequency drifts similar to type III bursts. The vast majority of the row chains exhibit negative frequently drift close to that of fiber bursts; their duraton is between 2 and 20 s. Some chains tend to assume the form of zebra or lace stripes, or of drifting bands of fiber bursts and bursts of the type III family, suggesting that such bursts might be resolved in spikes when viewed with high time/frequency resolution. Spikes in the 21 April 2003 event originated from a single source, 100″ NW of the SXR flare they were superimposed on a wider and slowly varying background source.

Radio, EUV and X-ray observations of the 18 April 2014 M7 class flare: what is the link between the eruptive plasma and the onset of the type II emission?

E. P. Carley, N. Vilmer, A. Kerdraon

Observatoire de Paris, LESIA, Meudon 92195, France

The 18 April 2014 GOES M7.3 flare was associated with a fast halo CME observed with SOHO/LASCO. It also produced an eruptive event observed by SDO/AIA in extreme ultraviolet and a fast shock revealed by the presence of a radio type II burst. The event was particularly well observed in the radio domain using Nanay observations. Indeed, an almost complete spectrum is obtained in the 10 MHz-1 GHz range combining the Nanay Decametric Array (DAM) with the more recent Orfees spectrograph (150 MHz-1 GHz). Furthermore, the Nanay Radioheliograph provides images of the event in the 150-450 MHz domain. In this contribution, we will show the first results obtained from the combination of radio and EUV data. We will in particular re-examine for this peculiar event the link between the properties of the eruptive plasma observed with SDO and the link of the eruptive material with the onset of the type II producing shock wave. Using high time and frequency resolution radio dynamic spectra, radio images and X-ray observations from RHESSI, we will also discuss the conditions under which energetic electrons are accelerated in this event.

Anomalous profiles of the C IV 1548Å and 1550Å observed with Soho/SUMER. A result of resonant scattering ?

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We present a few cases of C IV 1548Å and 1550Å anomalous spectral profiles, recorded with SOHO/SUMER in active region NOAA 8541. These profiles are found in 3 small areas of 2 to 3 arcsec size. The unique characteristic of these profiles is that the spectral shape of C IV 1548Å is very different from the one of C IV 1550Å. These two spectral lines are emitted by the same ion, therefore they are expected to have the same Doppler effect. We explain these observations by the effect of resonant scattering. Other possible explanations are also presented.

Interplanetary Type IV Bursts

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We studied 49 Interplanetary type IV bursts observed by the WIND/WAVES experiment in the 14-1.0 MHz frequency range. The high frequency extensions of these bursts were recorded by the RSTN (Guidice et al. 1981), DAM (Boischot et al. 1980), ARTEMIS-IV (Caroubalos et al. 2001), CULGOORA (Prestage et al. 1994) and HIRAISO (Kondo et al, 1995) Radiospectrographs. We examined the relationship of the type IV events with SOHO/LASCO CMEs and GOES SXR flares. The vast majority of the events (42) were found to be manifestations of the "Big Flare Syndrome" being associated with M and X

class flares and fast CMEs; their duration was on average 106 min. A smaller number of long lived events (from 570 min to 115 hours) appeared to "replenish" their energetic electron content possibly from electrons escaping from Coronal type IV bursts. Some of these were, mostly, accompanied by smaller flares and slower and more narrow CMEs than their majority counterparts. Among them was the unusual Interplanetary Type IV Burst of 2002 May 18–23 which is the longest event in the WIND/WAVES catalogue. Other minority type IV bursts started from an intense flare/fast CME yet their duration appeared extended, possibly, due to "replenishment".

"PSF" corrected SOT (Hinode mission) High Resolution Imaging Observations"

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We deduce the Point Spread Function (PSF) describing the smearing of instrumental origin due to i) the diffraction of the mirrors with a central obscuration system, ii) the stray light of parasitic origin and iii) the optical very small aberrations corresponding to the best focus images obtained with the Solar Optical Telescope (SOT) of the Hinode mission (ISAS/JAXA and NASA). The stray light is evaluated from both the amount of light observed inside the 60″ diameter disk of the planet Venus in projection on the solar disk, at time of the 2012 transit, and from the amount of light registered outside the solar disk. The Point Spread Function (PSF) corresponding to the best blue continuum Broadband Filter Imager (BFI) near 450.4 nm matches the theoretical model of the edge of the Sun outwards the inflection point and also the sharp edge of Venus during the egress, including the so- called Lomonossov arc due to refraction of solar light in high layers of its thick atmosphere. A combination of a Gaussian and of a Lorentz functions is selected to construct a PSF describing the diffraction (core of the PSF) and the large angles stray light (wings of the PSF). Removing the stray light and deconvolving the Venus image near the third contact (egress) by using a Max-likelihood deconvolution processing based on the adopted new PSF permits to better evaluate the Venus aureole effect. Results are also checked with the best theoretical models of the statistical granulation fluctuations (RMS) at disk centre. This deconvolution procedure was mainly applied to the sunspot observed on Febr-March 2007 in order to illustrate how effective is our restoration method on umbral fine structures such as umbral dots (UDs) and the newly discovered 0″2 to 0″4 dark wide umbral features (dark filaments, knots). They are not the dark lanes inside UDs predicted by magneto- convective models but a connection with UDs seems to exist. A movie was prepared from the images deduced after deconvolution, to illustrate the complexity of the dynamical behavior inside and around the sunspot for the deep layers seen in 450 nm. The colorimetric analysis performed using deconvolved images made in the Blue (450.4 nm) and the Green (555.05 nm) continuum show evidence of a large dispersion of corresponding temperatures, from 3000K to 8000K. Finally a new feature appearing for the 1st time at the extreme- limb of the disk (the last 100 km is concerned) is deduced.

Online ARTEMIS IV Solar Radio Databases: Type II List from 1998 to 2011

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The ARTEMIS IV Multichannel Radiospectrograph of the University of ATHENS Website `http://artemis-iv.phys.uoa.gr/` provides access to Solar Radio Databases, including the Type II List from 1998 to 2011 `http://artemis-iv.phys.uoa.gr/DataBaseForWeb/data_set_intro.htm`). Data listings of type II solar radio events recorded by ARTEMIS-IV from 1998 to 2011 are available linked to the FITS data files with cross links to associated CMEs in the LASCO lists. Dynamic Spectra of Observations, combined with SXR and RSTN light curves and the CME trajectotries are included; they are linked to the Radio Monitoring System of Nancay (`http://radio-monitoring.obspm.fr/`). Future plans include expansion of the database to newer events and augmentation with type IV and possibly Type III GG recordings. In this work we present the 1998–2011 Type II Lists organization and capabilities; from this dataset we use the type II characteristics in an investigation on the Coronal Magnetic Field.

Electron density and temperature in the solar corona from multi-frequency radio imaging

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The 2D images obtained through rotational aperture synthesis with the NRH are now suitable for quantitative exploitation. We show that measurements of the brightness temperature Tb beyond the limb allows to derive the coronal electron density, under weak hypothesis on the electron kinetic temperature Te in the corona, which, in turn can be derived from the observed mean spectra on the disk. Results are presented, from images at 6 frequencies from 150 to 450 MHz for 183 quiet days between 2004 and 2011. Density models in both EW and NS radial directions are given in the heliocentric distance r ranges 1.15-1.60 $R_\odot$ (EW) and 1.0-1.4 $R_\odot$ (NS). These models are averages over the summer months (May to August) of each year. The agreement between results from different frequencies (in the ranges of r where there is overlapping) shows the robustness of the method. In their ranges of heliocentric distances, these models are consistent with isothermal hydrostatic equilibrium. Their yearly variations are less than the dispersion between models derived from other techniques such as white light and EUV observations, partly because the latter ones are not time-averaged and refer to particular days. The radio models are generally less dense and show different behaviors with the solar cycle in the equatorial or polar radial directions. The scale-height temperature TH (1.5 MK) associated with our density models is found significantly higher than the coronal kinetic temperature Te (0.62 MK). This implies an ion temperature Ti of about 2.2 MK.

Non-twisted flux tube emergence and dynamics

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We study the emergence of a non-twisted flux tube from the solar interior into the solar atmosphere using 3D MHD simulations. We investigate the initial emergence and resulting dynamic phenomena in respect to the length of the buoyant part of the flux tube λ. We find considerable differences on the dynamics of the emergence of the flux tube when λ is varied. We find the formation and ejection of plasmoids, and the onset of hot and fast jets from the interface in a recurrent and intermittent manner. We show that small λ is a parameter that contributes to the coherence of the emerging flux tube.

Preliminary results of flash spectrum observations during the total solar eclipse of 20 March 2015 at Svalbard

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