Ground-based Solar Observations in the Space Instrumentation Era

Coimbra Solar Physics Meeting – CSPM-2015

October 5 - 9, 2015, Coimbra, Portugal

The Coimbra University, which is hosting the meeting, is one of the oldest European universities (founded in 1290). Full-disk spectroheliograms have been routinely taken in Coimbra since 1926 in the Ca II K-line (K1 and K3) and in 1990 regular observations in the Hα line have also started. In 2006, the Astronomical Observatory of the University of Coimbra (Coimbra, Portugal) – Observatório Astronómico da Universidade de Coimbra (OAUC) organized the first Coimbra Solar Physics Meeting (CSPM2006) jointly with a historical session commemorating the life and work of Prof. Francisco Costa Lobo (1864-1945) who installed the spectroheliograph in Coimbra in the 1920s. The instrument used is a twin of the spectroheliograph operated at the Observatoire de Paris-Meudon.

Now, the Geophysical and Astronomical Observatory of the University of Coimbra (OGAUC) invited again a wide scientific community to join us in 2015, this time for discussing the state-of-art of solar ground-based and space-based observing techniques and related topics. This meeting is included in the celebration of the 150 years of Geophysical Institute of the University of Coimbra. It will take place in the University campus just inside the Coimbra historical down-town and will also include an excursion to the Coimbra Observatory which is located at the city periphery.

The Sun and its activity affect the entire heliosphere, including the Earth. Solar activity includes flares, coronal mass ejections (CMEs), eruptive prominences and filaments, outbursts at various spatial scales, sunspots, and plages. All these phenomena are driven by the magnetic field. Although these phenomena appear at time scales from seconds to months, the long-term variation of the magnetic field during the 11-year solar cycle modulates their frequency and space weather impact. Coronal phenomena are driven by the dynamo-generated fields that show large-scale organization.

Solar magnetic fields can be investigated from ground and space. Ground-based observations of solar magnetic fields using polarimetry has a long history, contributing to the understanding of long-term behaviour of the Sun. Spectropolarimetric observations in FUV and EUV lines can only be made from space; they represent virgin territory and they are urgently needed for exploring the magnetic activity of the upper chromosphere and

transition region. This CSPM-2015 scientific meeting will cover various aspects of solar dynamic and magnetic phenomena which are observed over the entire electromagnetic spectrum: white-light, Hα, Ca II, and radio from ground and in a variety of other wavelengths (white light, UV and EUV, and X-rays) from space. Emphasis will also be placed on instrumentation, observing techniques, and solar image processing techniques, as well as theory and modelling through detailed radiative transfer in increasingly realistic MHD models. The long-term (cyclic) evolution of solar magnetism and its consequence for the solar atmosphere, eruptive phenomena, solar irradiation variations, and space weather, will be in focus. Here, special attention will be devoted to the long-term observations made in Coimbra and also to the results of the SPRING / SOLARNET and SCOSTEP VarSITI studies. In particular, the weak solar activity during the current solar maximum will be discussed. Finally, since this meeting is organised around the 90th anniversary of performing the first spectroheliographic observations in Coimbra, a session will be specially dedicated to new solar instruments (both ground-based and space-borne) that will give access to unexplored solar atmospheric features and dynamic phenomena over the coming years.

The CSPM-2015 largely benefits from a significant support of the following institutions to which we would like to express our gratitude: SCOSTEP/VarSITI, European Space Agency, Observatoire de Paris-Meudon, Fundação Para a Ciencia e Tecnologia, Departamento de Matemática da Universidade de Coimbra.

Welcome to Portugal, welcome to Coimbra, welcome to CSPM-2015 !

Ivan Dorotovič and João Fernandes
on behalf of the SOC and LOC

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To contact the LOC: cspm2015@mat.uc.pt

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OGAUC – Observatório Geofísico e Astronómico da Universidade de Coimbra
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Webpage of the CSPM2015

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The LOC would like to take this opportunity to thank to the following

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for their kind help and financial support to this scientific event:

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FACULDADE DE CIÊNCIAS E TECNOLOGIA
UNIVERSIDADE DE COIMBRA

SCIENTIFIC PROGRAMME OF THE MEETING

Sunday, 4 October

Arrival, ***18.00*** – ***20.00:*** Registration and welcome drink
(*Department of Mathematics, Largo D. Dinis, Coimbra*)

20.30: Meeting of the SOC/LOC

Monday, 5 October

Morning (8.45 –12.30)

Welcome addresses
(*Department of Mathematics UC, Largo D. Dinis, room Pedro Nunes*)

Session 1: Observations of the Sun
Chairperson: M. Verma

Invited Review 1: Quiet Sun and its dynamics as viewed from the ground and from space – **K. Tziotziou**

I. Kontogiannis, G. Tsiropoula, K. Tziotziou: A study of a quiet solar network region structure and dynamics using ground and space based observations

R. Gafeira, A. Lagg, M. van Noort, S. K. Solanki: Temporal variations in small scale chromospheric fibrils observed by Sunrise II

T. M. D. Pereira et al.: Clashing views of spicules and fibrils

Coffee break 10.35 – 11.05 (Poster viewing)

Invited Review 2: Magnetic flux emergence in the quiet Sun – **L. Bellot Rubio**

M. Bodnárová, D. Utz, J. Rybák: Possible chromospheric response to the dynamics of photospheric G-band bright points

Invited Review 3: Quiet Sun magnetism: a new perspective from GRIS / GREGOR – **A. Lagg**

12.30 – 14.30 Lunch

Afternoon (14.30 – 18.00)

Session 1: Observations of the Sun
Chairperson: G. Tsiropoula

Invited Review 4: Sunspot structure and evolution – **C. Denker**

M. Verma, C. Denker, S. J. González Manrique, M. Sobotka and the GREGOR Team: High-resolution 3D flow fields around solar active regions

P. Romano, V. Capparelli, M. Falco, S.L. Guglielmino, A. Jhel, M. Murabito, F. Zuccarello: Study of photospheric and chromospheric dynamics using high resolution spectropolarimetric observations

C. Robustini, J. Leenaarts, J. De la Cruz Rodriguez, L. Rouppe Van Der Voort: Peacock jets above the light bridge of a sunspot

Coffee break 16.05 – 16.35 (Poster viewing)

M. Sobotka, J. Dudík, C. Denker, H. Balthasar, J. Jurčák, W. Liu, and the GREGOR Team: Slipping reconnection in a solar flare observed with GREGOR

G. Trottet, **J.-P. Raulin**, A. MacKinnon, C. G. Giménez de Castro, P. J. Simões, D.Cabezas, V. de La Luz, M. Luoni, P. Kaufmann: Origin of the 30 THz emission during the 2012 March 13 solar flare at 1720 UT

P. Kotrč, P. Heinzel, O. Procházka: On measurements of continuum flux in solar flares. Instrument and first results

Evening (18.15): Welcome reception
(*Museu Nacional de Machado de Castro, Largo Dr. José Rodrigues, Coimbra*)

Tuesday, 6 October

Morning (9.00 – 12.30)

Session 1: Observations of the Sun
Chairperson: M. Temmer

Invited Review 5: Observational needs for understanding solar magnetic activity and the formation of large-scale transient events – **L. van Driel-Gesztelyi**

P. K. Manoharan: Radial evolution of coronal mass ejections in the inner heliosphere

R. D. Cunha-Silva, **F. C. R. Fernandes**, C. L. Selhorst: Shock wave driven by CME evidenced by metric type II burst and EUV wave

Coffee break 10.15 – 10.45 (Poster viewing)

Invited Review 6: The need for synoptic solar observations from the ground – **A. A. Pevtsov**

L.O.T. Fernandes, P. Kaufmann, E. Correia, C. G. Giménez de Castro, A. Marun, P. Pereyra, J.-P. Raulin, A. B. M. Valio: Comparative study of solar bursts at sub-THz frequencies

P. Schwartz, P. Heinzel, S. Jejčič, J. Rybák, P. Kotrč, F. Fárník, Yu. A. Kupryakov, E. E. DeLuca, L. Golub, P.R. Jibben, U. Anzer, A.G. Tlatov, S. A. Guseva: Is it possible to use the green coronal line instead of X rays to cancel an effect of the coronal emissivity deficit in estimation of the prominence total mass from decrease of the EUV-corona intensities?

A. Kobelski, T.S. Bastian: Probing Solar wind turbulence with the Jansky Very Large Array

12.30 – 14.30 Lunch

Afternoon (14.30 –18.00)

Session 2: Solar image management, spectro-polarimetric and processing techniques
Chairperson: L. van Driel-Gesztelyi

Invited Review 1: Image restoration techniques for solar ground-based imaging - **M. Löfdahl**

B. Schmieder, N. Labrosse, P. Levens, A. Lopez Ariste, S. Gunár: Magnetic field and plasma diagnostics from coordinated prominence observations

Invited Review 2: The effects of instrumental properties on Stokes Inversions – **M. van Noort**

Coffee break 16.00 – 16.30 (Poster viewing)

Invited Review 3: The visualization of solar data: volume, variety, and value – **J. Ireland**

A. Hamada, T. Asikainen, I. I. Virtanen and K. Mursula: Identifying coronal holes from synoptic maps of SOHO/EIT and SDO/AIA EUV images

T. Barata, P. Pina, S. Carvalho, R. Gafeira, A. Garcia: Ground based observations of sunspots from the observatory of Coimbra: evaluation of different automated approaches to analyse its datasets

J. Palacios and the SeNMEs team: Solar eruptive events as seen by the Spanish Space Weather Service SeNMEs

Wednesday, 7 October

Morning (9.00 – 12.15)

Session 3: Theory and modeling - comparison to observations
Chairperson: P. Schwartz

Invited Review 1: Modeling the Mg II h & k lines observed by IRIS and the Ca II H & K lines observed from the ground – **J. Leenaarts**

A. Sukhorukov, J. Leenaarts: Implementation of partial frequency redistribution effects for chromospheric resonance spectral lines in 3D model atmospheres

N. Vitas, E.Khomenko: Solar Magnetoconvection simulated with the MANCHA code

Coffee break 10.15 – 10.45 (Poster viewing)

Invited Review 2: On the role of MHD waves in heating localised magnetic structures: Where are we? – **R. Erdélyi**

D. Passos: Meridional circulation dynamics: comparing observations and results from EULAG global 3D MHD simulations

M. Loukitcheva: Probing the Sun with ALMA: observations and simulations

12.15 – 13.45 Lunch

Afternoon (13.45 – 19.00)

Excursions: Spectroheliograph – Geophysical and Astronomical Observatory of the UC; Conimbriga – ruins of the ancient roman town

Thursday, 8 October

Morning (9.00 – 12.30)

Session 3: Theory and modeling – comparison to observations
Chairperson: R. Erdélyi

Invited Review 3: Numerical simulations of dynamic phenomena in the solar corona – **T. Török**

S. T. Wu, N. Gopalswamy: What Additional Measurements Are Needed for the Magnetohydrodynamic (MHD) Simulation of Solar Atmospheric Dynamics?

J. Thalmann, Y. Su, **M. Temmer**, A.M. Veronig: Exceptions to the rule: the X-flares of AR 2192 lacking coronal mass ejections

I. Chifu, B. Inhester, T. Wiegelmann: Coronal magnetic field modeling using stereoscopy constraints

Coffee break 10.35 – 11.05 (Poster viewing)

Session 4: Long-term variations of the Sun
Chairperson: D. Maia

Invited Review 1: Long term solar activity – **I. Usoskin**

F. Clette, L. Lefévre, E.W. Cliver, L. Svalgaard: The revised sunspot number: new properties and new data standards

A.Tlatov, K. Kuzanyan, V. Vasilyeva: Tilt angles of solar filaments over the century: 1919-2014

M. Roth: The Solar Physics Research Integrated Network Group - SPRING

12.30 – 14.30 Lunch

Afternoon (14.30 – 17.45)

Session 4: Long-term variations of the Sun
Chairperson: J. Palacios

Invited Review 2: Long-term Synoptic Observations of CaII-K and Magnetic Flux – **L. Bertello**

T. Chatzistergos, I. Ermolli, S. K. Solanki, N. A. Krivova: Exploiting historical Ca II K spectroheliogram archives: Preliminary results from four archives

Invited Review 3: Space Weather using ground based data – **A. Veronig**

Coffee break 16.00 – 16.30 (Poster viewing)

R. F. Pinto, A. Rouillard: The slow and fast solar wind during the activity cycle

A. Morozova, J. J. Blanco, P. Ribeiro: Co-variability of the atmospheric and geophysical parameters in mid-latitude troposphere

Discussion on revised sunspot number series: Knowns and unknowns about the sunspot activity for the last three centuries

Evening (20.15): Conference dinner in the "Palácio de São Marcos", an old Portuguese edifice located at 20 km from Coimbra.

Friday, 9 October

Morning (9.00 – 12.30)

Session 4: Long-term variations of the Sun
Chairperson: I. Kontogiannis

Invited Review 4: Variations of the solar irradiance – **S. K. Solanki**

J. Padmanabhan: Are we on the verge of a Maunder-like Grand Solar Minimum?

T. Barlyaeva, P. Lamy, A. Llebaria: The State of the Corona during the Weak Solar Cycle 24: the View from LASCO Images

Coffee break 10.15 – 10.45 (Poster viewing)

Session 5: Facilities for ground-based and space solar observations
Chairperson: M. Sobotka

Invited Review 1: The GREGOR Solar Telescope – **W. Schmidt**

H.-P. Doerr: High-precision spectroscopy with extremely accurate wavelength calibration: centre to limb variation of line shapes and convective shifts

Invited Review 2: European Solar Telescope (EST) – **M. Collados**

12.30 – 14.00 Lunch

Afternoon (14.00 – 16.30)

Session 5: Facilities for ground-based and space solar observations
Chairperson: F. Clette

Invited Review 3: Chinese Giant Solar Telescope – **Y. Deng**

M. van Noort: MiHI: a new imaging spectrograph

Invited Review 4: Solar Orbiter - Exploring the Sun-Heliosphere Connection – **D. Müller**

Invited Review 5: Science Objectives and Instrument Designs of the SOLAR C Mission – **Y. Suematsu**

Conclusions of the Meeting

17.00: Meeting of the SOC/LOC

P O S T E R S

- Presenting authors of posters can find his/her corresponding poster table according to a code given to each poster.

Session 1: Observations of the Sun

S1.1 - I. Dorotovič, M. Rybanský, M. Sobotka, M. Lorenc, M. Barandas, J. M. Fonseca: Evolution of photospheric pores in the magnetic field

S1.2 - L. S. Sampaio, R. D. Cunha-Silva, **F. C. R. Fernandes:** Analysis of the evolution of halo coronal mass ejection of March 09, 2012 associated with EUV waves

S1.3 - F. C. R. Fernandes, R. D. Cunha-Silva, Z. A. L. Sodré, R. A. Felipe, J. R. Abalde, M. N. M. Galdino, J. D. B. Sinadinse: Statistical analysis of solar radio emissions recorded in meter wavelengths by CALLISTO-BR

S1.4 - R. Miteva, P. Kaufmann, D. P. Cabezas, M. M. Cassiano, **L. O. T. Fernandes**, S. L. Freeland, M. Karlicky, A. Kerdraon, A. S. Kudaka, M. L. Luoni, R. Marcon, J.-P. Raulin, G. Trottet, S. M. White: Solar flare observations at 30 THz

S1.5 - C. Fischer, N. Bello González and R. Rezaei: Quiet sun magnetic field evolution observed with Hinode SOT and IRIS

S1.6 - M. Hagino, K. Ichimoto, S. Ueno, G. Kimura, R. Kitai, L. Zhong, Z. Xu, K. Otsuji, K. Shinoda, H. Hara, Y. Suematsu, T. Shimizu: Development of the Universal Tunable Filter and High-resolution Imaging Observation with the Fuxian Solar Observatory

S1.7 - E. Jensen, C. Heiles, A. Kepley, **A. Kobelski**, D. Wexler: Measuring the Solar Magnetic Field with STEREO A&B Faraday Rotation Observations using the 100m Green Bank Telescope

S1.8 – M. Korsós: Evolution of ARs at photosphere before flare and CME occurrence

S1.9 - P. Kotrč, W. Liu, Y. Kupryakov, M. Bárta, L. Kashapova: Analysis of a limb eruptive event

S1.10 - T. Libbrecht, J. de la Cruz Rodriguez: Exploring the diagnostic value of Helium I D3 in the chromosphere

S1.11 - H. Pazira, D. Kiselman: The chromosphere as imaged in O I 777.2 nm

S1.12 - A. Valio, D. F. Silva - Millimeter Observations of the 2013 February 17 Solar Flare

Session 2: Solar image management, spectro-polarimetric and processing techniques

S2.1 - N. Anugu: Efficient solar scene wavefront estimation with reduced systematic and RMS errors

S2.2 - Z. Kobyliński, J. Biały, T. Seredyn: Comparison of detection and tracking methods of CME fronts in sequences of satellite coronograph images

S2.3 - J. Palacios, S. Vargas Domínguez , L. A. Balmaceda, I. B. Cabello García, V. Domingo: Multi-wavelength observations of vortex-like flows in the photosphere from ground-based and space-borne telescopes

S2.4 - A.-A. A. Abseim, **M. A. Semeida**, M. Y. A. Saleh, S. M. A. Youssef: Modified cloud method validation for determining physical parameters of a moderate flare on June 26, 1999

S2.5 - J. Shetye, J. G. Doyle, E. Scullion, C. Nelson: Analysis of apparent ultra-fast spicules using high resolution ground-based data

S2.6 - Z. A. Luz Sodré, F. C. R. Fernandes: Observational and physical parameters of type I chains and their association with flares in X-ray

S2.7 - F. Tardelli-Coelho, J. R. Abalde, A. J. de Abreu: Interference of magnetic storms in plasma bubbles in the ionosphere over a period of solar minimum

Session 3: Theory and modeling - comparison to observations

S3.1 - J. P. Bjørgen: Numerical radiative transfer using a multigrid method

S3.2 - J. J. Blanco and M.A. Hidalgo - Magnetic flux conservation in magnetic clouds

S3.3 - R. F. Pinto, N. Vilmer, P. Browning, M. Gordovskyy - X-ray emission in simulations of flaring coronal loops

S3.4 - P. Schwartz, H. Balthasar, C. Kuckein, J. Koza, P. Gömöry, J. Rybák, A. Kučera, P. Heinzel - Non-LTE inversion of spectropolarimetric and spectroscopic observations of a filament on 11 September 2014 at the VTT

S3.5 - B. Vršnak, T. Zič, J. Čalogovič, M. Dumbovič - Forecasting the arrival of Coronal Mass Ejections: The Drag-Based Model

Session 4: *Long-term variations of the Sun*

S4.1 - J. Aboudarham, C. Renié**:** Filaments data since 1919: A basis for statistics

S4.2 - E. Asvestari, I. G. Usoskin, N. A. Krivova, R. H. Cameron: Semi-empirical long-term reconstruction of the heliospheric parameters validated by cosmogenic radionuclide records

S4.3 - L. Biktash: Sun and space weather influence on global temperature by the agency of cosmic rays during the solar cycles 19-23

S4.4 - V. N. Ishkov: Solar flare phenomena and their manifestation in the different epochs of the solar activity

S4.5 - B. Kim, J. Lee, S. Oh, Y. Yi: Temporal variations of Solar and Interplanetary conditions for the last 4 decades

S4.6 - Z. Kobyliński, A. Wysokiński, T. Seredyn: Solar cycle 25 forecast using Elman recurrent networks

S4.7 - P. K. Manoharan: Three-dimensional Evolution of Solar Wind during Solar Cycles 22-24

S4.8 - E. C. Okoro and F. N. Okeke: Relationship between Variation of Total Ozone Concentration and Severe Geomagnetic Storms over Lagos in Nigeria

S4.9 - Y.-d. Park: New Software for Space Weather

S4.10 - A. Tlatov, N. N. Skorbez: Numerical processing of sunspot images using the digitised long-term archives

S4.11 – **I. Usoskin**: The Maunder minimum: A reassessment from multiple datasets

Session 5: Facilities for ground-based and space solar observations

S5.1 - J. J. Blanco, J. Medina, O. García, R. Gómez-Herrero, I. García, S. Ayuso: CaLMa a neutron monitor in Iberian peninsula

S5.2 - H. Alvarez-Pol, A. Blanco, **J. J. Blanco**, J. Collazo, P. Fonte, J. A. Garzon, A. Gomez, G. Kornakov, T. Kurtukian, L. Lopes, M. Morales, A. Morozova, M. A. Pais, M. Palka, V. Perez Munuzuri, P. Rey, P. Ribeiro, M. Seco, J. Taboada: Tragaldabas: a muon ground-based detector for the stuty of the solar activity

S5.3 – J. Čalogović, M. Dumbović, B. Vršnak, R. Brajša: Photosphere and chromosphere telescope at Hvar Observatory

S5.4 - S. Ueno, K. Shibata, K. Ichimoto, S. Nagata, **I. Dorotovič**, E. Shahamatnia, R. A. Ribeiro, J. M. Fonseca**:** Roles of Ground-based Solar Observations of Hida Observatory toward the Solar-C Era

S5.5 - Y. Hanaoka: Past and Present of the Synoptic Observations of the Sun at the National Astronomical Observatory of Japan

S5.6: F. Iglesias, A. Feller, N. Krishnappa, S.K. Solanki: Fast Solar Polarimeter: Prototype characterization and first results

S5.7 - The ALMA Solar Development Team: T. S. Bastian, M. Bárta, R. Brajša, B. Chen, B. De Pontieu, G. Fleishman, D. Gary, A. Hales, R. Hills, H. Hudson, G. Hurford, K. Iwai, **A. Kobelski**, S. Krucker, M. Shimojo, I. Skokic, S. Wedemeyer, S. White, Y. Yan - Solar Observations with the Atacama Large Millimeter/ submillimeter Array (ALMA)

S5.8 - I. Kontogiannis, A. Belehaki, G. Tsiropoula, I. Tsagouri, A. Anastasiadis, A. Papaioannou: Integrating ground-based and space-born observations to create a new space weather facility at the National Observatory of Athens

S5.9 - A. Kučera, J. Ambróz, P. Gömöry, P. Habaj, J. Kavka, M. Kozák, P. Schwartz, J. Rybák, S. Tomczyk, S. Sewell, P. Aumiller, R. Summers, L. Sutherland, A. Watt: The CoMP-S instrument at the Lomnicky Peak Observatory - status report

S5.10 - T. Manik, **P. Sitompul**, M. Batubara, T. Harjana, C. Y. Yatini, C. Monstein: Solar Radio Observation using Callisto Spectrometer at Sumedang West Java Indonesia: Current status and Future Development Plan in Indonesia

A B S T R A C T S

(ordered alphabetically according the surname of the presenting author)

Session 4 - Poster

Filaments data since 1919: A basis for statistics

J. Aboudarham, C. Renié, LESIA, OV Paris Data Center, Observatoire de Paris, Meudon, France

From 1919 to 2002, Paris-Meudon Observatory published synoptic maps of the Solar activity. Together with maps, tables were provided, containing some information concerning at least filaments. The board of Paris Observatory funded a data capture program concerning the 680 000 basic informations available in those tables. On the other hand, in the frame of the FP7 European project HELIO, a Heliophysics Feature Catalogue (HFC) has been developed, which contains also filaments data from 1996 up to now. We now pool all these data in order to give access to a filaments database for nearly a century of observations. This allows to make statistical studies of those Solar features, and try to correlate them with other information such as sunspot number, ... We present here the first results of such studies, showing long-term global behavior of filaments.

Session 2 - Poster

Efficient solar scene wavefront estimation with reduced systematic and RMS errors

N. Anugu, P. Garcia, CENTRA-SIM, Universidade do Porto, Portugal

Wave front sensing for solar telescopes is commonly implemented with Shack-Hartmann sensors. The Shack-Hartmann lenslet sub-aperture solar image shifts/slopes are usually estimated with correlation algorithms. The sub-pixel precision image shifts are computed by applying a peak-finding algorithm to the correlation peak (Lofdahl 2010). Usually, the measured image displacements consist of systematic errors due to pixel locking effects (Sjodahl 1994), because correlation matching is limited only to an integer pixel grid. The amplitude of the systematic error depends on the combination of the correlation algorithm chosen to compute the correlation peak with the type of peak-finding algorithm chosen. To study the systematic errors in detail, solar sub-aperture synthetic images are constructed by using a Swedis Solar Telescope solar granulation image (Carlsson 2013).
The performance of different cross-correlation peak finding algorithms is investigated. The algorithms are: parabola (Poyneer 2003); quadratic polynomial (Lofdahl 2010); threshold center of gravity (Bailey 2003); Gaussian (Nobach 2005) and Pyramid (Bailey 2003. It is found that pyramid fit is the most robust to pixel locking effects. The RMS error analysis study reveals that threshold centre of gravity behaves better in low SNR although systematic errors in the measurement are large. It is found that no peak finding model is good enough in attenuating both systematic errors and RMS error.
A new method is proposed to overcome the above limitations. It works in two steps. In the first, the cross-correlation is executed at the original image spatial resolution grid (1 pixel). In the second, the cross-correlation is performed with a sub-pixel level grid and by confining the field of view to 4 x 4 pixels centered at the first step delivered initial position. The generation of these sub-pixel grid based search windows from the spatially discrete target image is achieved with bi-linear interpolation. This method is called as cross-correlation executed at continuous grid (CCC). This technique was previously reported in electronic speckle photography (Sjodahl 1994). This technique is applied to wave front sensing. The combination of coarse level grid search executed in large field followed by quasi-continuous grid search executed in a small field enables one to achieve high accuracy wave front estimation by reducing the systematic errors with a low computational cost. The results show that the proposed method outperforms all the approaches in the first study. It improves the wave front estimation accuracy to a factor

of 5 in terms of both systematic error and RMS error (75% systematic error reduction, for 0.2 pixel sub-sampling grid), at the expense of twice the computational cost. It is also observed that the method have very low failure rates.
The CCC method is strongly recommended for wave front sensing in solar telescopes, particularly in open loop adaptive optics, for measuring large the dynamic shifts. Furthermore, by selecting appropriate sub-sampling in trade-off between the aimed sub-pixel image shift accuracy and the computational speed limitation, it can be employed in closed loop adaptive optics effectively.

Session 4 - Poster

Semi-empirical long-term reconstruction of the heliospheric parameters validated by cosmogenic radionuclide records

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We develop a semi-empirical model describing the heliospheric modulation of galactic cosmic rays in terms of different heliospheric parameters such as the heliospheric current sheet tilt angle, the open solar magnetic flux and the polarity of the large scale solar magnetic field. This model is an improvement of a previous similar model by Alanko-Huotari et al. (2006). The parameters are fitted using the observations and reconstructions of the heliospheric parameters for the period 1976 - 2013, which includes the latest very weak solar minimum. The modulation potential is reconstructed since 1610 using this model and different reconstructions of the open solar magnetic flux and it is used to estimate the production and distribution of the cosmogenic isotopes ^{14}C and ^{10}Be. These estimates have been compared with terrestrial archives in ice cores and tree rings.

Session 2 - Speaker

Ground based observations of sunspots from the observatory of Coimbra: evaluation of different automated approaches to analyse its datasets

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The success of several solar missions is allowing obtaining a huge amount of high resolution images from the surface of the Sun. Therefore the use of to the digital image processing techniques has increased accordingly with the aim of getting information about the solar activity in a prompt and efficient way.
Several image processing and detection approaches have being developed and tested in the last years. For instance, neural networks have been used to detect the solar activity of the solar winds, protons events, with an automatic tracking of solar flares. Thresholding techniques, region growing, edge detection, Hough transform, and fuzzy sets have been applied in the detection of sunspots, active regions, filaments and CMEs. Hybrid methods that include different approaches have also been developed. Mathematical morphology has been applied to sunspots and in filaments' recognition. A common aspect between all these works is the need to incorporate pre-processing techniques, before the main processing and feature extraction task, with the aim of homogenizing the solar images in terms of dimension, size and intensity, and of removing the limb darkening.
The comparison between automatic and manual methods is presented in Zharkova et al. (2005), proving the higher efficiency of the automatic methods. The developed algorithms for filaments tracking and active regions survey, constitute the first steps for

the building of an approach that can allow the following of the solar activity evolution. The advancements and results of these many applications, especially as sunspots are concerned, have also contributed for the building of solar activity catalogues, being the EGSO (European Grid of Solar Observations) a good example of this.
Nevertheless, in addition to have more data from the new instruments and space missions, it is yet important to maintain older instruments working and to use their data for several important reasons. One of them is the long-term observations of, at least, several decades they have been performing, crucial to understanding the solar cycle. Besides, ground-based observations allow us to preserve and extend consistent data sequences.
The versatility of the automatic methods is also high, not only due to its ability for characterizing and quantifying parameters of the solar activity, but also for its applicability in any type of image (from high resolution to spectroheliograms, for example). However, in what concerns ground-based images, the application of automatic methods can present some additional difficulties, due the Earth's atmosphere and meteorological factors.
The Geophysical and Astronomical Observatory of the University of Coimbra has a collection of solar observations (spectroheliograms) that span dozens of years, acquired on a daily basis since 1926 and already in digital format. This exceptional collection must be processed since their importance for the knowledge of the solar activity.
Given the different approaches, some of them already mentioned, this work aims to evaluate the capability of some methods in the automatic detection of sunspots from spectroheliograms. The objective of this work is to define a strategic action to be applied to all spectroheliograms datasets.
In order to illustrate that strategy, a set of images belonging to solar cycle 24, from October to November of 2014, was chosen to test and integrate several algorithms, developed by different research groups, with quite different and up-to-date approaches from image analysis and pattern recognition. The final results will be compared to reference detections by an expert solar observer, to evaluate the performances on the detection of the contour of sunspots, the ability to to differentiate the umbra and spot areas, and also their numbers. According to the best detection rate performances (its accuracy but also computational time, among others), a processing chain will be implemented and applied to all long data series of OGAUC.

Session 4 - Speaker

The State of the Corona during the Weak Solar Cycle 24: the View from LASCO Images

T. Barlyaeva, P. Lamy, A. Llebaria (Laboratoire d'Astrophysique de Marseille, France)

The LASCO-C2 coronagraph aboard SOHO continues its white-light imaging of the corona from 2 to 6 solar radii, thus allowing investigating the consequences of the weak Solar Cycle 24 on the corona and comparing it to the previous cycle. Temporal variations of the radiance of the corona and of its electron content, either global or integrated in limited regions (e.g., equatorial version polar) are studied and compared with various proxies of solar activity in order to identify the driving mechanisms that control the activity of the corona. Particular attention is paid to the mid-term variations which are distinctly different between the two cycles. We highlight the similarities and differences between the Solar Cycles 23 and 24. Finally, we rely on our ARTEMIS-II catalog of coronal mass ejections (CMEs) to compare their rates and properties (spatial distribution, velocity, mass) during these two cycles.

Session 1 - Invited Speaker

Magnetic flux emergence in the quiet Sun

L. Bellot Rubio, Instituto de Astrofísica de Andalucía - CSIC, Granada, Spain

The solar internetwork is the site of vigorous flux emergence on small spatial scales. Flux appears in supergranular cells in the form of unipolar and bipolar patches, at a rate of

120 Mx cm-2 day-1. Upon appearance, magnetic elements start to move toward the cell boundaries - the network. Their mean lifetime is 7 minutes, but many of them survive longer and interact with other features on their way to the network. Bipolar structures, both small-scale magnetic loops with two footpoints and clusters of opposite-polarity patches that emerge on the same area of the solar surface within a short time interval, are responsible for more than 50% of the total internetwork flux. These are the longest-lived magnetic elements. They interact with preexisting fields and produce brightenings in the chromosphere and transition region as they rise into the atmosphere. Such elements may be important contributors to chromospheric heating. The rest of the flux appears in situ as unipolar features. They tend to be smaller and have shorter lifetimes. Flux disappears from supergranular cells through transfer to the network, fading, and cancellation, at a very similar rate of 125 Mx cm-2 day-1. About 40% of the flux present in the internetwork ends up in the network, supplying as much flux as it contains on time scales of only 10 hours. Fading is an equally important flux loss mechanism, followed by cancellations. The flux appearance and disappearance rates are enormous. However, the fact that a significant fraction of the internetwork flux shows up as unipolar features and disappears by fading suggests that they are the result of the concentration and dispersal of background flux which is too weak to be detected above the noise level. This component is probably flux recycled from the network, rather than newly emerged flux. If so, the actual flux emergence and disappearance rates may be smaller than implied by the observations. In this talk I will review our current understanding of flux emergence processes and interactions in the quiet Sun, using long-duration, high cadence, magnetograph observations acquired by Hinode to illustrate the evolution of small-scale magnetic elements in the solar atmosphere.

Session 4 - Invited Speaker

Long-term Synoptic Observations of CaII-K and Magnetic Flux

L. Bertello, A. A. Pevtsov, National Solar Observatory, USA

Long-term synoptic observations in the resonance line of Ca II K and measurements of the solar magnetic flux over several decades constitute a fundamental database for a variety of retrospective analyses of the state of the solar magnetism. These data archives may also hold the key for untangling some of the mysteries behind the solar dynamo, which in turn could result in a better predictive capability of current dynamo models. Synoptic Ca II K observations began in 1907 at the Kodaikanal observatory (India) and in 1915 at the Mt Wilson (California, USA) solar observatory. By the early 1970s a number of synoptic programs for solar magnetic observations were established that provided full disk magnetograms. These programs include measurements carried out at the Mt Wilson 150-foot solar tower, Wilcox observatory (California, USA), and by the National Solar Observatory (NSO, USA). Today the NSO is continuing these observations through its Synoptic Optical Long-term Investigations of the Sun (SOLIS) facility. I will review some of these historical observations, their properties, and their importance for understanding the behavior of the solar magnetic field over multidecadal time scales. I will also show recent results about using Ca II K spectroheliograms and sunspot magnetic field measurements to reconstruct homogeneous series of pseudo-magnetograms prior the magnetograph era.

Session 4 - Poster

Sun and space weather influence on global temperature by the agency of cosmic rays during the solar cycles 19-23

L. Biktash, IZMIRAN, Troitsk, Moscow, Russia

We have studied conditions on the sun and in interplanetary space, which can have an influence on solar and galactic cosmic rays (CR) and climate change. In this connection the solar wind and interplanetary magnetic field parameters and cosmic ray variations have been compared with geomagnetic activity represented by the equatorial Dst index from the beginning 1965 to the end 2012. The important drivers in interplanetary

medium which have effect on cosmic rays as CMEs (coronal mass ejections) and CIRs (corotating interaction regions) undergo very strong changes during their propagation to the Earth. Because of this the sunspot numbers (SSN) do not adequately reflect peculiarities concerned with the solar wind arrival to 1 AU. Therefore, the geomagnetic indices have some inestimable advantage as continuous series other the solar wind measurements. We have compared the yearly average variations of Dst index and the solar wind parameters with cosmic ray data from Moscow, Climax, Haleakala and Oulu neutron monitors during the solar cycles 19-23. During the descending phases of these solar cycles (CSs) the long-lasting solar wind high speed streams occurred frequently and were the primary contributors to the recurrent Dst variations. They also had effects on cosmic rays variations but were not reflected by SSN. We show that long-term Dst variations in these solar cycles were correlated with the cosmic ray count rate and can be used for prediction of CR variations. Climate change in connection with evolution of Dst index and CR variations is analyzed. We show that CRs play essential role in climate change and main part of climate variations can be explained by the mechanism of action CRs modulated by the solar activity on the state of lower atmosphere and meteorological parameters.

Session 3 - Poster

Numerical radiative transfer using a multigrid method

J. P. Bjørgen, J. Leenaarts (Institutet för solfysik, Stockholms University, Sweden)

Solving the 3D non-LTE radiative transfer problem in stellar atmospheres is computationally demanding. We have implemented a non-linear multigrid scheme in the radiative transfer code MULTI3D. The important advantages of the multigrid scheme are the very high convergence rate, and that the convergence speed does not deteriorate when the discretization is refined. Both properties are highly desirable for solving the radiative transfer problem for high-resolution atmosphere models produced by MHD codes. We present timing tests and example calculations based on atmosphere models computed with the Bifrost code.

Session 5 - Poster

CaLMa a neutron monitor in Iberian peninsula

J. J. Blanco, J. Medina, O. García, R. Gómez-Herrero, I. García, and S. Ayuso (University of Alcalá - UAH, Madrid, Spain)

Castilla-La Mancha neutron monitor (CaLMa) is a cosmic ray observatory located in Guadalajara (Spain). Its geographical location (40°38’N, 3°9’W) , its height above see level (708 m) and its vertical rigidity cut-off (6.97 GV). CaLMa is sensitive to cosmic rays with energies above 6 MeV (primary cosmic rays: protons). Cosmic rays are strongly modulated by solar activity at these energies, this fact convert CaLMa in a ground-base observatory of solar activity. Enhancements in CaLMa's count-rate can be observed caused by strong solar flares and shock-driven by coronal mass ejections. Decreases in CaLMa's count-rate are caused by solar wind disturbances arriving Earth. Interplanetary shock waves, interplanetary coronal ejections and interaction regions use to produce these decreases (Forbush decreases). CaLMa is in operation since October 2011 and among its observations we find more than 20 Forbush decreases and the evolution of the current solar cycle. CaLMa is also part of the neutron monitor global network and provide real-time data to the neutron monitor data base.

Session 3 - Poster

Magnetic flux conservation in magnetic clouds

J. J. Blanco and M. A. Hidalgo (University of Alcalá - UAH, Madrid, Spain)

Magnetic clouds are magnetic structures into interplanetary coronal mass ejections. The structure of magnetic cloud evolves during its travel over the solar wind toward the outermost limit of the heliosphere. Direct observations on magnetic clouds from Helios

mission, show us that the magnetic field is reduced and their size grows up with the distance to Sun. The magnetic flux is expected to be conserved if erode processes are not present along the magnetic cloud path into solar wind. This work study this magnetic flux conservation using a set of magnetic cloud observed during the Helios mission.

Session 5 - Poster

Tragaldabas: a muon ground-based detector for the stuty of the solar activity

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A new RPC-based cosmic ray detector, TRAGALDABAS (acronym of "TRAsGo for the AnaLysis of the nuclear matter Decay, the Atmosphere, the earth's B-field And the Solar activity") has been installed at the Univ. of Santiago de Compostela, Spain (N:42°52'34", W:8°33'37"). The detector, in its present layout, consists of two 1.8 m2 planes of two 1mm-gap glass RPCs. Each plane is readout with 120 pads with grounded guard electrodes between them to minimize the crosstalk noise. The main performances of the detectors are: an arrival time resolution of about ~300 ps, a tracking angular resolution below 3°, a detection efficiency close to 1, and a solid angle acceptance of ~5 srad. Another two planes of RPC detectors will be added in the next future in order to improve both the resolutions and the acceptance. TRAGALDABAS will be able to monitor the cosmic ray low energy component strongly modulated by solar activity. Its cadence and its angular resolution will allow to study in detail, small variations in cosmic ray anisotropy. These variations can be a key parameter to understand the effect of solar disturbances on the propagation of cosmic ray in the inner heliosphere and, maybe, provide a new tool for space weather analysis.

Session 1 - Speaker

Possible chromospheric response to the dynamics of photospheric G-band bright points

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We studied spectroscopic signatures of potential means of energy transport into the chromosphere by investigating temporal variations of the width, the intensity and the Dopplershift of the Hα spectral line profile observed by the tunable Lyot filter installed on the Dutch Open Telescope. Furthermore, we studied co-spatial chromospheric and photospheric structures with a likelihood of being causally connected to the variations of these spectroscopic signatures. We found oscillations in the intensity and Doppler velocities, while the width of the Hα spectral line profile produced no discernible periodicity. Moreover, the amplitude of the intensity is lagging behind the Doppler velocities. We interpret our findings as signatures of magneto-acoustic wave propagation. The investigation of the likely source of the observed oscillations directed our attention to bright chromospheric mottles. Subsequently, we studied the possible relation of their appearance wit h a co-spatial long-living and dynamically evolving group of G-band bright points (GBPs). According to our findings we propose a causal relation between the

dynamical evolution of the group of GBPs and the appearance of bright mottles in the region above them.

Session 5 - Poster

Photosphere and chromosphere telescope at Hvar Observatory

J. Čalogović, M. Dumbović, Bojan Vršnak, Roman Brajša, Hvar Observatory, Faculty of Geodesy, Kačićeva 26, HR-10000 Zagreb, Croatia

The double solar telescope at the Hvar Observatory consists of two Carl Zeiss refractors, attached as one unit on a German parallax mounting. The photosphere telescope has an objective diameter of 217 mm and the chromosphere telescope has a diameter of 130 mm. It provides a valuable instrument to study rapid changes of chromospheric and photospheric features. Using a field of view of about 11 and 7 arcmin, it aims to produce high-resolution and high-cadence imaging of active regions on the Sun. Modern Pulnix TM-4200GE 12-bit 4 megapixel CCD cameras allow to obtain time series with a cadence up to 30 images per minute. High-cadence chromosphere ground-based observations are an important tool to identify and study solar flares, filaments and other solar phenomena that are associated with coronal mass ejections and their propagation to the Earth. Hence these observations can be also used to improve space weather forecasts. This work has been supported by the ESF project PoKRet and the Croatian Science Foundation project SOLSTEL.

Session 4 - Speaker

Exploiting historical Ca II K spectroheliogram archives: Preliminary results from four archives

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Regular measurements of the solar irradiance began in the late 1970s. Longer timeseries are essential in order to acquire an insight about the long-term solar variability, and improve our understanding of the solar dynamo. It is also crucial for the assessment of the Sun's impact on Earth's climate and understanding the underlying mechanisms.
Century-scale reconstructions of irradiance variations have been accomplished by using sunspot data alone, e.g. sunspot number and areas (partly also including their position). However these data only indirectly provide information on the bright plage component in active regions and do not adequately describe the weaker ephemeral regions that are believed to be the main driver of the longer-term secular changes.
Full disc Ca II K spectroheliograms can potentially give information about the surface distribution of the Sun's magnetic flux. Regular observations in the Ca II K line started at the beginning of the 20th century at various observatories around the globe (including at Coimbra), some of which have been digitised, rendering them unique datasets to study the solar variability for over 100 years.
However, broad and accurate analysis of these observations requires development of automatic procedures that allow to work out problems raised by e.g. defects in and decay of spectroheliogram photographic plates, missing photographic calibration, undocumented changes of the instrumentation.
We developed methods to overcome the main problems affecting historical Ca II K observations and photometrically calibrate the available datasets by using information that they intrinsically carry (under some assumptions). We tested the accuracy of the proposed methods with synthetic images. We present the developed methods and report on the progress so far with the calibration and analysis of selected datasets.

Session 3 - Speaker

Coronal magnetic field modeling using stereoscopy constraints

I. Chifu, B. Inhester, T. Wiegelmann (Max Planck Institute for Solar System Research, Göttingen, Germany)

To obtain the 3D-structure of coronal magnetic loops two complementary methods have been used in the past: 1) Extrapolating the measured photospheric field vector into the corona and 2) Stereoscopy with coronal EUV images from the two STEREO-spacecraft. Some authors tried to combine the two methods. They used the extrapolation of the magnetic field, in most cases with linear force-free models, in order to do a better identification and match of the loop pairs for the stereoscopic reconstruction. Within this work we present a novel approach and use stereoscopic reconstructed loops from STEREO/EUVI as a constraint for nonlinear force-free coronal magnetic field extrapolations. For this aim we extended a nonlinear force-free optimization code by an additional functional, which monitors and minimizes the difference of the force-free magnetic field model and the 3D plasma loops.

Session 4 - Speaker

The revised sunspot number: new properties and new data standards

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In 2015, a new entirely recalibrated version of the sunspot number and group number series has been released. Important changes, by up to 40%, have been applied to the original historical series, leading to a new picture of the secular evolution of solar activity, without significant upward trend between the 17th and the 20th century.
We first describe the main changes and implications of this very first revision of the sunspot number series since its creation, more than 165 years ago. We also discuss the long-term non-linear relation between the sunspot number and the group number, as it is now free from artifacts. Both series are now largely reconciled, but do not fully overlap, clearly reflecting different properties of the solar cycle.
Together with this major step, several important changes were simultaneously adopted regarding past conventions. We will explain the various modifications and their motivations, in order to help users making the proper adaptations. In particular, A.Wolfer was chosen as the new reference, in place of R. Wolf, thus dropping the fixed 0.6 Zürich factor. For the group numbers, given the time variability of the average number of spots per group, we don't apply anymore a constant scaling factor to match the average scale of the sunspot number, in contrast with the previous series by Hoyt and Schatten (1998). Finally, we present the new data sets and data formats adopted for this revised series and for the future production of the sunspot number. The new SILSO Web portal will provide access both to current and past versions of the series, allowing to keep track of future revisions and thus giving more flexibility to follow future progresses in sunspot science. Finally, we conclude on the redefinition of the base method used to routinely produce the sunspot number from all current and future observations of the SILSO worldwide network. New tools and statistical approaches derived directly from our global recalibration work will soon be ported to our operational software, improving the quality control and the long-term stability of the sunspot number series. This will complete the necessary modernization of our only direct long-term record of solar activity.

Session 5 - Invited Speaker

EST: Prospects for the new large-aperture high-resolution European facility

M. Collados, Instituto de Astrofísica de Canarias, La Laguna, Tenerife, Spain

The European Solar Telescope started its conceptual design in 2008 with the main scientific aim of studying the solar atmosphere, from the deep photosphere up to the

high chromosphere, with excellent spatial resolution and magnetic sensitivity. Its design led to a concept with a polarimetrically compensated design (to minimise the instrumental polarisation and facilitate the measurement of weak magnetic fields as well as tiny spatial and temporal variations) together with an ambitious adaptive optics system. To achieve it scientific goals, a set of instruments will be operated simultaneously to probe the different layers of the solar atmosphere. Under the present SOLARNET and GREST EU projects, new integral field techniques are under development to facilitate the simultaneous measurement of the polarised spectrum in a 2D field of view, as well as the study of large etalons that are required for narrow-band tunable filters operating at a large aperture telescope. In addition, present solar facilities are used as test benches for new operational procedures to make ground-based data easily accessibe to the whole community. Among other activities, automatic reduction routines, a prototype data archive with ground-based data linked to Virtual Observatory tools and a service observing mode are under development. In this talk, the present status of all activities that are being carried around EST will be described, as well as the future perspectives for this facility.

Session 5 - Invited Speaker

Chinese Giant Solar Telescope

Y. Deng, Z. Liu, H. Ji, NAOC, Chinese Academy of Sciences, Beijing, China

Chinese solar community has proposed a next generation ground-based solar telescope - Chinese Giant Solar Telescope (CGST). CGST will be an Infrared and Optical telescope, with spatial resolution equivalent to 8m and light-gathering power equivalent to 5m. The preliminary designs and some progress of CGST will be presented in our talk.

Session 1 - Invited Speaker

Sunspot Structure and Evolution

C. Denker, Leibniz Institute for Astrophysics (AIP), Potsdam, Germany

The evolution of sunspots from simple pores to complex active regions intriguingly shows the variety of interactions between plasma flows and strong magnetic fields (e.g., Evershed flow, moat flow, and shear flows in flaring active regions). The global picture of the evolution is nowadays easily accessible from ground-based synoptic instruments and space missions. At the same time, the Japanese Hinode mission and meter-class solar telescopes on the ground reveal the instricate fine-structure of sunspots including penumbral filaments and umbral dots. High-resolution spectropolarimetry and advanced spectral inversion codes provide a wealth of information regarding the three-dimensional magnetic and flow features. Besides reviewing some of the latest advances in high-resolution sunspot physics, this talk presents recent sunspot observations obtained at Observatorio del Teide, Spain with the Vacuum Tower Telescope (VTT) and the GREGOR solar telescope.

Session 5 - Speaker

A new instrument for high-precision spectroscopy with extremely accurate wavelength calibration

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The new prototype instrument LARS (Lars is an Absolute Reference Spectrograph) at the German Vacuum Tower Telescope, Tenerife, provides unique possibilities for precision spectroscopy of the Sun and of light sources in the lab. Spectral resolution, achievable signal to noise ratio (SNR) and straylight properties are similar to the Fourier-transform spectrometer (FTS) of the Kitt Peak McMath facility. A laser frequency comb enables an absolute wavelength calibration that is accurate at some parts in 109 and provides the spectral point spread function for each measurement as a by-product.

We present the first results from observing runs carried out in the early science phase of the instrument. A set of high-fidelity centre to limb observations of selected photospheric FeI lines was obtained. Absolute convective shifts were determined with respect to highly accurate laboratory measurements carried out with the same instrument. The statistics of many repeated observations of the quiet Sun at disc centre allow us to quantify the variability one has to expect in line position as well as in line shapes. We demonstrate the potential of such new, high-fidelity spectroscopic observations of the average solar photosphere for the verification and refinement of numerical simulations.

Session 1 - Poster

Evolution of photospheric pores in the magnetic field

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We describe conditions of pore formation in relation to the configuration and intensity of magnetic field. We use observations of the SDO/HMI instrument, which observes the photosphere in continuum and simultaneously the magnetic field with a spatial resolution of better than 1" and a temporal resolution of 45 s. We analyze a time-sequence of evolution of area and brightness of pores, their statistics, and in parallel a time-sequence of the line-of-sight magnetic field intensity and its correlation with the area and brightness. Sunspot observations from the Hurbanovo Observatory are used for the selection of a suitable area on the solar disc. A pore (small sunspot) observed near the central meridian at the Hurbanovo Observatory on October 11, 2013 was selected for analysis. We chose from each SDO image only area with a diameter of 1.05° (35" as seen from the Earth). Points of the area were transformed into rectangular coordinates (Δl, b) and for the alignment of individual images we found from the movement of a pore the synodical rotational speed: ω = 14.35°/24 hours, which is by 1°/24 higher than the tabular value. We traced the selected area from 22:01:30 h UT (October 10, 2013) to 20:01:30 h UT (October 11, 2013) in 83 images with a temporal resolution of 15 minutes. Evolution of the area was analyzed using an animation and quantitative results are derived from data files. At least 6 pores appeared in the area during the reported period. Pores are visible if a ratio p (p = intensity in the pore/background intensity) decreases below 0.85. The background noise is at a level of 5% (granulation). The magnetic induction is at the same time approximately 600 Gauss. The maximum diameter of the pores is of about 5" (10 pixels), the minimum value of p is 0.49 when B = 1200 Gauss. The course of evolution is presented in a tabular form. Aim of the analysis is demonstrated also using selected images from SDO in cooperation with CTS-UNINOVA/CA3 (Caparica, Portugal).

Session 5 - Poster

Roles of Ground-based Solar Observations of Hida Observatory toward the Solar-C Era

S. Ueno (1), K. Shibata (1), K. Ichimoto (1), S. Nagata (1), **I. Dorotovič** (2,3), E. Shahamatnia (2), R.A. Ribeiro (2), J.M. Fonseca (2), 1 - Hida Observatory, Kyoto University, Japan; 2 - CTS-UNINOVA, FCT/UNL, Caparica, Portugal; 3 - Slovak Central Observatory, Hurbanovo, Slovak Republic

Full-disc solar images, obtained both with the ground-based solar telescopes and the instruments onboard the satellites, provide essential observational material for solar physicists and space weather researchers for better understanding the Sun, studying the evolution of various features in the solar atmosphere, and also investigating solar differential rotation by tracking such features along time. For the realization of the Solar-C satellite, discussions about scientific themes and preliminary observations are internationally carried out now.

At Hida Observatory of Kyoto University, we will play the following roles toward the Solar-C era by utilizing the Domeless Solar Telescope (DST) and the international solar chromospherirc full-disk observation network (CHAIN project) that includes the Solar Magnetic Activity Research Telescope (SMART). In addition, with the collaboration of UNINOVA (Portugal) we will discuss the suitability of applying a hybrid Particle Swarm Optimization (PSO) algorithm and Active Contour model on SMART (Hida Observatory, Japan) images for tracking and determining the differential rotation of sunspots.
1) Roles before the Solar-C launch:
By using DST's focal plane and high-dispersion and wide-wavelength spectroscope, Hida Observatory will play a role as the place of the development of new detectors and focal plane instruments. On the other hand, we will reveal unclear points in the chromospheric physics and in methods of deriving physical quantities of chromosphere, by carrying out spectrum observations and polarization measurements in various chromospheric absorption lines.
2) Roles after the Solar-C launch:
Promotion of cooperative observations with Solar-C, mainly by observations with the DST. Our Hida Observatory will perform complimentary observations with satellite's high-spatial-resolution observations that are limited in the spatial FOV and continuous observable time due to the data capacity and lifetime of the satellite, or satellite's spectroscopic observations that are limited in the amount of information along the wavelength direction. Moreover, we will expand and apply new knowledge provided by Solar-C to the whole of the sun, through our international full-disk solar monitoring network observation (CHAIN project). It will mediate between the Solar-C and studies of variations of space weather and space climate.
3) Regular roles:
Our observatory continues to provide the place of educational-observation training for students and young researchers where they can gain experiences that they operate instruments by their own hands while watching the Sun in real time. Moreover, we provide the place that can enforce not only scientific advanced themes, but also other themes that are hard to be accepted in the case of satellites or hard to be carried out by satellites physically, for example, experimental themes, classical scientific themes, themes that need long duration or large data capacity, and educational themes etc.

Session 1 - Invited Speaker

Observational needs for understanding solar magnetic activity and the formation of large-scale transient events

L. van Driel-Gesztelyi (1,2,3); 1 - University College London, Mullard Space Science Laboratory, UK; 2 - Observatoire de Paris, LESIA, Paris-Meudon, France; 3 - Konkoly Observatory, Budapest, Hungary

The temperature in the solar atmosphere ranges over three orders of magnitude from the photosphere to the corona, which extends up to four during periods of transient activity. Consequently, the wavelengths we can observe certain details of large-scale transients, i.e. coronal mass ejections (CMEs) and related flares range over from radio, through optical to X-rays. Non-thermal effects further broaden the range. Large transients show signatures at most wavelengths, which in turn provide highly complementary information, necessary for a synthesis. To form an increasingly complete observational picture of CMEs, we need broad and ever-broadening multi-wavelength, multi-instrument observational coverage both from the ground and space. As the formation of CMEs involve long time-scales and only probabilistic predictions are available for their onset time, we need long synoptic sequences. Once the onset is imminent, the sequence of events accelerates and there is a need for high-cadence observations. Even in the low corona, CMEs couple small scales (e.g. flare in their source active region) and large scales (e.g. the extent of a Moreton or global EUV wave). Therefore we need high spatial resolution observations focused on the small-scale, but should we neglect its large-scale signatures and its interaction with surrounding magnetic fields, we will never fully understand a CME. As CMEs travel from the solar corona through the interplanetary

space, they need to be tracked by coronagraphs, radio instruments adapted to the low-frequency plasma emission, and their magnetic fields and plasma measured in situ. I will give an overview of multi-wavelength CME signatures and emphasize the importance of magnetic field measurements in particular, necessary to make progress in understanding their formation.

Session 3 - Invited Speaker

On the role of MHD waves in heating localised magnetic structures: Where are we?

R. Erdélyi, Solar Physics & Space Plasma Reserach Centre (SP2RC), School of Mathematics & Statistics, University of Sheffield, UK

Satellite and ground-based observations from e.g. SOHO, TRACE, STEREO, Hinode, SDO and IRIS to DST/ROSA, IBIS, CoMP, STT/CRISP have provided a wealth of evidence of waves and oscillations present in a wide range of spatial scales of the magnetised solar atmosphere. Our understanding about localised solar structures has been considerably changed in light of these high spatial and time resolution observations. However, MHD waves not only enable us to perform sub-resolution magneto-seismology of magnetic waveguides but are also potential candidates to carry and damp the necessary non-thermal energy in these localised waveguides. First, we will briefly outline the basic recent developments in MHD wave theory focussing on linear waves.
Next, we will concentrate on the role of the most frequently studied wave classes, including the Alfven, and magneto-acoustic kink and sausage waves. The current theoretical (and often difficult) interpretations of the detected solar atmospheric wave and oscillatory phenomena within the framework of MHD will be shown. Their photospheric origin and generation mechanism and how these waves penetrate into the chromosphere, transition region or even into the corona will be addressed.
Last, the latest reported observational findings of potential MHD wave flux, in terms of localised plasma heating, in the solar atmosphere with some surprising results will be discussed, bringing us closer to solve the coronal heating problem.

Session 1 - Speaker

Shock wave driven by CME evidenced by metric type II burst and EUV wave

R. D. Cunha-Silva, **F. C. R. Fernandes**, C. L. Selhorst (Universidade do Vale do Paraíba - UNIVAP, São José dos Campos, Brazil)

Solar type II radio bursts are produced by plasma oscillations in the solar corona as a result of shock waves. The relationship between type II bursts and coronal shocks is well shown by observations since the 1960s. However, the details of the association between the drivers of the shocks and the metric type II bursts remains a controversial issue. The flares and the coronal mass ejections (CMEs) are considered as potential drivers of these shocks. In this work, we present the analysis of a metric type II burst observed on May 17, 2013, by spectrometers from e-CALLISTO network (extended-Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatories) and EUV images from the Extreme Ultraviolet Imager (EUVI), aboard the Solar Terrestrial Relations Observatory (STEREO). The event was associated with an M3.2 X-ray flare and a halo CME. The EUV images clearly show the EUV wave was produced by the expansion of the CME. The heights of the EUV wave fronts and the magnetic field intensity determined in the regions of the shock are consistent with those the heights of radio source obtained with the three-fold Newkirk density model, which provided a clue to an oblique propagation of the shock. The finding of an accelerating shock with speed of 530-640 km/s and of 870-1220 km/s for the first and the second stages of the type II emission, respectively, is consistent with both the average speed of the associated EUV wave front, of 626 km/s, during the initial expansion of the CME, and with the linear speed of the CME, of 1345 km/s. These results will be presented and discussed.

Session 1 - Poster

Analysis of the evolution of halo coronal mass ejection of March 09, 2012 associated with EUV waves

L. S. Sampaio, R. D. Cunha-Silva, **F. C. R. Fernandes** (IP&D, Universidade do Vale do Paraíba - UNIVAP, São José dos Campos, SP, Brazil)

This work consists on analysis of evolution of an halo type coronal mass ejection (CME) recorded on March 09, 2012 by LASCO instrument on board of SOHO satellite. CME presented velocity of 950 m/s and the EUV images recorded by the Extreme Ultraviolet Imager (EUVI), aboard the STEREO show evidence of shock wave produced by the expansion of the CME. The event was also associated with an M.6 class X-ray solar flare, starting at 03:22 UT, peaking at 03:53 UT and ending at 04:18 UT, recorded by the GOES satellite. Also a type II radio bursts were recorded in metric wavelength band (100-250 MHz) by e-Callisto spectrographs. The following spectro-temporal parameters of type II burst were estimated from the dynamic spectrum: starting frequency of (220 ± 5) MHz; ending frequency of (170 ± 5) MHz; starting and ending time of about 03:41:51 UT and 03:46:49 UT; and frequency bandwidth of 34,3 MHz. The results are presented and discussed.

Session 1 - Poster

Statistical analysis of solar radio emissions recorded in meter wavelengths by CALLISTO-BR

F. C. R. Fernandes, R. D. Cunha-Silva, Z. A. L. Sodré, R. A. Felipe, J. R. Abalde, M. N. M. Galdino, J. D. B. Sinadinse (IP&D, Universidade do Vale do Paraíba - UNIVAP, São José dos Campos, SP, Brazil)

In this work, we report the statistical analysis of metric type III bursts recorded in metric frequency range (45 - 870 MHz) by CALLISTO-BR (Compound Astronomical Low frequency Low Cost Instrument for Spectroscopy and Transportable Observatory) spectrographs, in operation at Cachoeira Paulista, Brazil, since 2010. Assuming an improved density model and the emission at second harmonic, the beam parameters of type III bursts are determined. The observational and physical parameters for 292 isolated type III bursts recorded between January and December of 2010 were estimated. The average values obtained for this sample are: the electron density of 5.0 x 107 cm-3; the heliocentric distance of the emitting source of 1.4 solar radii; the electron beam velocity of 1.4 x 105 km/s; the intensity of the magnetic field at the acceleration region of about 2 G; the temperature of the emitting source of 2 x 106 K; the total number of electrons in the beam of 1.7 x 1033 electrons and the beam density of 2.3 x 105 cm-3. These preliminary results will be extended for the sample of type III bursts recorded between 2011 and 2014 and they will be presented and discussed.

Session 1 - Speaker

Comparative Study of Solar Bursts at Sub-THz Frequencies

L. O. T. Fernandes (1,2), P. Kaufmann (1,2), E. Correia (1,3), C. G. Giménez de Castro 1; A. Marun (4), P. Pereyra (5), J.-P. Raulin (1), A. B. M. Valio (1); 1 - Centro de Rádio Astronomia e Astrofísica Mackenzie, Escola de Engenharia, Universidade Presbiteriana Mackenzie, São Paulo, SP, Brasil; 2 - Centro de Componentes Semicondutores, Universidade Estadual de Campinas, Campinas, SP, Brasil; 3 - Instituto Nacional de Pesquisa Espacial (INPE), São José dos Campos, SP, Brasil; 4 - Instituto de Ciencias Astronómicas, de la Tierra y del Espacio (CONICET), San Juan, Argentina; 5 - Complexo Astronómico El Leoncito (CONICET), San Juan, Argentina.

Solar burst radio emissions at sub-THz frequencies have revealed a new spectral component with fluxes increasing with frequency, apparently simultaneous but separated from the well known emissions at microwaves. The intriguing THz emissions bring challenges for interpretation. Observations were obtained at frequencies centered at 0.2 and 0.4 THz by the Solar Submm-w Telescope (SST) at El Leoncito, at 2550 m altitude in

the Argentina Andes. We discuss the quality these observations which is poor compared to microwaves and mm-waves. Principal uncertainties arise from approximate estimates of variable atmosphere transmission, and to the irregular three SST 0.2 THz beam shapes used in the partially overlapping beams technique to determine the burst position, especially in weak bursts. Good to fair atmosphere transmission conditions at El Leoncito are found for less than 205 days/year at 0.2 THz and 180 days/year 0.4 THz. The two principal factors lead to flux uncertainties of the order of ± 25%. In 2012-2013 they were complemented by 45 GHz and 90 GHz radio-polarimeters, also operated at El Leoncito. Sub-THz bursts were compared to microwaves obtained by RSTN (2.695, 4.995, 8.8, and 15.4 GHz). Complete radio spectra were derived, when possible, from the GHz to the sub-THz range of frequencies. The selected bursts were compared to GOES soft X-ray bursts, and at other space or ground-based observations, when available. Preliminary results have shown that 5 out of 13 bursts exhibited 0.4 THz fluxes larger than 0.2 THz; 2 impulsive bursts were observed at 0.4 THz only. The observed 0.4 THz fluxes ranged from 50-200 SFU; all sub-THz bursts were associated to 9 GOES M-class and to 4 X-class bursts. Two of these bursts were also observed at 30 THz, exhibiting fluxes 1-2 orders of magnitude larger than at microwaves, mm-w and sub-THz frequencies.

Session 1 - Poster

Solar flare observations at 30 THz

R. Miteva (Space Research and Technology Institute, Bulgarian Academy of Sciences, Bulgaria and CRAAM/MPU, Brazil), P. Kaufmann (CRAAM/MPU and State University of Campinas, Brazil), D. P. Cabezas (CRAAM/MPU, Brazil), M. M. Cassiano (CRAAM/MPU, Brazil), **L. O. T. Fernandes** (CRAAM/MPU, Brazil), S. L. Freeland (Lockheed Martin Solar and Astrophysics Laboratory, USA), M. Karlicky (Astronomical Institute of the Academy of Sciences of the Czech Republic), A. Kerdraon (LESIA-Observatoire de Paris, France), A. S. Kudaka (CRAAM/MPU, Brazil), M. L. Luoni (Institute of Astronomy and space Physics, CONICET/UBA, Argentina), R. Marcon (State University of Campinas and Bernard Lyot Solar Observatory Campinas, Brazil), J.-P. Raulin (CRAAM/MPU, Brazil), G. Trottet (LESIA-Observatoire de Paris, Meudon), S. M. White (Air Force Research Laboratories, Space Vehicles Directorate, USA)

We report the detection of an intense 30 THz impulsive burst on 1 August 2014 with the equipment installed at the Center of Radio Astronomy and Astrophysics (CRAAM) in Mackenzie Presbyterian University (MPU), Sao Paulo, Brazil. The event is associated with a GOES M2 class solar flare. The maximum flux at 30 THz was about 19000 sfu, almost two orders of magnitude larger than measured at microwave frequencies. The microwave emissions at higher frequencies exhibit a suggestive time association with the 30 THz peak. At the metric-to-decimetric frequency range a superimposed short duration burst occurs close to the peak of the 30 THz emission while the underlying slower emission maximum is progressively delayed for lower frequencies. The dynamic radio spectrum shows signatures of drifting pulsations and reversed type III-like radio bursts. No emissions in white light or sub-millimeter wavelengths were detected. Hard X-rays produced by the event was partially observed by the FERMI satellite only at the beginning, because the satellite was eclipsed by the terrestrial atmosphere. A good correspondence between the temporal profiles and positions at 30 THz, EUV and H-alpha wavelengths was observed. The flaring source seen at EUV and H-alpha has finer spatial structures not resolved within the 30 THz 15 arc-seconds photometric beam. It is suggested that the 30 THz, EUV and H-alpha brightening originate from a common flaring site at the low chromosphere. A comparative analysis with the first reported 30 THz burst on 13 March 2012 is presented.

Session 1 - Poster

Quiet sun magnetic field evolution observed with Hinode SOT and IRIS

C. Fischer, N. Bello González and R. Rezaei (Kiepenheuer-Institut für Sonnenphysik, Freiburg, Germany)

We have calibrated and aligned a co-spatial and co-temporal 3 hour quiet sun time series taken with the Hinode and IRIS satellites. Hinode SOT observed full Stokes profiles of the Fe I 630 line pairs with the Spectro-polarimeter (SP) scanning a 8.7 arcsec region with a cadence of about 70 seconds. The Broadband Filter Imager (BFI) observed in Ca II H with a cadence of 31 s which was complemented by magnetograms and dopplergrams constructed from Na D I 589,6 nm measurements observed by the Narrowband Filter Imager (NFI). The IRIS satellite recorded slit jaw images centered at 2832 Å (112 s cadence), 1390 Å (23 s) and with a cadence of 19 s at 2796 Å. The spectrograph recorded spectra in several passbands including the Mg II k and h lines performing a 2 step raster with a 9.5 s step cadence.
We study magnetic elements seen in SP and NFI data undergoing a magnetic field intensification process accompanied by the development of bright points in the Ca II H images which we identify as convective collapse events. In addition we study pairs of magnetic elements involved in flux cancellation. The magnetic elements pass the IRIS slit at different stages of these processes. The IRIS Magnesium lines spectra are analyzed to investigate the response of the chromosphere to the magnetic events in the photosphere below. We present the temporal evolution of the atmospheric parameters from the photosphere to the transition region during these occurrences and compare the results to convective collapse and flux cancellation models.

Session 1 - Speaker

Temporal variations in small scale chromospheric fibrils observed by Sunrise II

R. Gafeira (1), A. Lagg (1), M. van Noort (1), S. K. Solanki (1,2), 1 - Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany, 2 - School of Space Research, Kyung Hee University, Yongin, Gyeonggi 446-701, Republic of Korea

In June 2013 the SuFI instrument on board the Sunrise observatory recorded images in the narrow-band Ca II H filter at 396.8 nm of an active region with emerging magnetic flux for about one hour. These data of the solar chromosphere are characterized by a very high spatial resolution and unprecedented temporal stability. In this study we concentrate on small-scale chromospheric fibrils with diameters of down to 0.20 arcsec, close to the diffraction limit of the Sunrise telescope. The aim is to evaluate the morphological properties and intensity variations of the individual fibrils. This allows us to characterize properties like lifetime, elongation, curvature, brightness and its variation along and transversal to the fibrils. These parameters and their relation with the underlying magnetic field, measured with the Sunrise IMaX instrument, will shed light on the importance of these fibrils as the coupling agent between the photosphere and the corona.

Session 1 - Poster

Development of the Universal Tunable Filter and High-resolution Imaging Observation with the Fuxian Solar Observatory

M. Hagino (1), K. Ichimoto (2), S. Ueno (2), G. Kimura (2), R. Kitai (3), L. Zhong (4), Z. Xu (4), K. Otsuji (1), K. Shinoda (1), H. Hara (1), Y. Suematsu (1), and T. Shimizu (5); 1 - NAOJ, Tokyo, Japan, 2 - Kyoto University, Japan, 3 - Bukkyo University, Kyoto, Japan, 4 - National Astronomical Observatory of China, Beijing, China, 5 - Japan Aerospace Exploration Agency

We have developed a new narrowband universal tunable filter to perform imaging spectroscopy of the solar chromosphere for future application to space (ex. Solar-C) and

ground-based observations. Using Liquid Crystal Variable Retarders (LCVRs) as the elements for tuning the wavelength, it is possible to make high speed tuning (about 0.1sec) without mechanical drives (and oil tank), and using wide-band polarizers and super achromatic half-wave plates, the filter can be usable over the wide range of wavelength (510-1100nm). This filter builds up with seven stages each consisting of a pair of calcites, LCVR, half-wave plates and linear polarizer. The full width at half maximum (FWHM) of the filter transmission is about 0.025nm at 656.3nm. The developing phase of the filter has almost finished and we shift to scientific observation phase by using large ground-based telescopes.
Using the filter, high-resolution images were taken with the 1m vacuum solar telescope at the Fuxian Solar Observatory, Yunnan Observatory of China during 19-30 January 2015. Several flares and fine structures of the chromospheric layer were observed during the term. In this paper, the observation will be reported in detail. Especially, we will discuss about motions in a filament related M-class flare on 30 January 2015.

Session 2 - Speaker

Identifying coronal holes from synoptic maps of SOHO/EIT and SDO/AIA EUV images

A. Hamada, T. Asikainen, I. I. Virtanen and K. Mursula (ReSoLVE Centre of Excellence, Department of Physics, University of Oulu, Finland)

Coronal holes are regions of open magnetic field lines and the source of fast solar wind. Understanding the evolution of coronal holes is critical for solar magnetism as well as for accurate space weather forecasts. Long-term occurrence gives fundamentally important information for solar dynamo and space climate studies. Solar wind models are highly sensitive to the size and location of the holes on solar disk.
Coronal holes are best seen in images of coronagraphs at the solar limb. However, coronal holes are difficult to determine on the solar surface since they appear differently in different wavelengths. The size, shape, intensity and contrast of any given hole are not the same when using different observing filters.
We study here the synoptic EUV images at wavelengths of 195 Å and 193 Å measured by SOHO/EIT and SDO/AIA instruments, respectively. We aim to identify the coronal holes from these images using an automated routine based on the statistical properties of the measured pixel intensities and a dynamical division of images into sub-images. We present here the method and the first results obtained for coronal hole properties from these two databases. We compare the results with other methods based on different routines.

Session 5 - Poster

Past and Present of the Synoptic Observations of the Sun at the National Astronomical Observatory of Japan

Y. Hanaoka (National Astronomical Observatory of Japan)

The National Astronomical Observatory of Japan has a history of about 100 years of regular synoptic solar observations. It started with Ca K spectroheliographic and white-light imaging observations, and shortly afterward, sunspot count was started. Current imaging observations are being carried out in the H-alpha line, the green continuum, and the G-band. In addition, the NAOJ has a history of more than 30 years of magnetic field measurements, and now we are conducting full-Sun spectropolarimetry observations in the wavelengths of He I 10830/Si I 10827 and Fe I 15648. These observational results contribute not only to monitoring the solar active phenomena from the viewpoint of the space weather, but also to studying the long-term variability of the solar activity, thanks to the long history. Most of historical photographic (plates and films) and hand-drawn data have been digitized and are now open at our web site as well as recently obtained data. In the meeting, we will introduce our data to promote the collaboration in the long-term solar activity study.

Session 5 - Poster

Fast Solar Polarimeter: Prototype characterization and first results

F. Iglesias (1), A. Feller (1), N. Krishnappa (1), and S. K. Solanki (1,2); 1 - Max-Planck-Institut für Sonnensystemforschung, Justus-von-Liebig-Weg 3, 37077 Göttingen, Germany; 2 - School of Space Research, Kyung Hee University, Yougin, Gyeonggi 446-701, Korea

Due to the differential and non-simultaneous nature of polarization measurements, seeing induced crosstalks and seeing limited spatial resolution can easily counterbalance the benefits of ground based Solar imaging polarimetry. It is known that fast modulation in combination with high frame rate can help with these issues. In his line, we are developing the Fast Solar Polarimeter (FSP). FSP prototype is based on a high frame-rate (400 fps), low-noise (< 3 e- RMS), pnCCD camera, and ferroelectric liquid crystals. The fast polarization modulation, yielding up to 100 full-Stokes measurements per second, and high duty cycle (~ 95%), have the double propose of reducing seeing induced artifacts and improving the final spatial resolution by providing an optimal regime for the application of post-facto image reconstruction techniques. In this work we describe the FSP prototype and present some of the first measurements obtained with the 68-cm, Vacuum Tower Telescope located in the Observatorio el Teide, Spain.

Session 2 - Invited Speaker

The Visualization of Solar Data: Volume, Variety, and Value

J. Ireland, NASA Goddard Space Flight Center / ADNET Systems, Inc.

As the volume and variety of solar data increases, the challenge of quickly and reliably extracting scientific value from the data also increases. Since visualization of the data is often the first step in understanding the physical processes of the Sun, the tools we use to browse, explore and understand the Sun must keep pace with the complexity of the data. There are also many different audiences for solar data, and they each have very different data visualization needs.
The Helioviewer Project is a solution to the visualization challenges presented by the volume and variety of solar data. The aim of the Helioviewer Project is to design systems and services which give users everywhere the capability to explore the Sun and inner heliosphere and to give transparent access to the underlying data. The project uses a mix of new and established technologies to provide capabilities that allow intuitive visual browsing of the Sun and inner heliosphere at arbitrary time and length-scales.
In this talk I will describe how the volume and variety of solar data shaped the design, operation and current capabilities of the Helioviewer Project. I will also describe how new image datasets, such as those that will be available from the Daniel K. Inouye Solar Telescope and Solar Orbiter can be made available through the Helioviewer Project. Finally, I will discuss extensions to the project that will make it easier for users everywhere to explore the volume and variety of solar data.

Session 4 - Poster

Solar flare phenomena and their manifestation in the different epochs of the solar activity

V. N. Ishkov, IZMIRAN, Troitsk, Russia

Researches of distribution and physical characteristics of solar flare events in different epochs of solar activity (SA) manifestation has been conducted. Modern methods of instrumental observations of the like events cover period 20 - 24 SC that includes a SC of "increased" (20 - 22) SA, transition period (part 22nd and 23th SC) and part (growth branch) SC of "lowered" (24) SA. During all these epochs the regime of a magnetic field generation in a convective zone of the Sun was significantly different that has to lead to different manifestations of sunspot-forming and flare activities. If in inside epochs background magnetic fields though significantly differ, but remain constants, in the transition periods the magnetic fields rearrange themselves to the levels typical for

different epochs of SA. So for the transition period from the epoch of "increased" to the epoch of "lowered" SA (SC 23) have been falling of mean and polar magnetic field (Svalgaard) levels and the magnetic field strength in the sunspot umbra (the effect of Penn-Livingston). Because the solar flare events are a result of the interaction of the new emerging magnetic fluxes with the already existing magnetic fields of active regions, the observed proofs of a difference in the process of the preparation, realization and power in the realization of the periods flare energy release in different epochs of solar activity are given. Attracting regular ground-based observations of solar flare events in the line at 6563 Å (Ha) and in other spectral lines that are sensitive to flare process can extend the time period of our study. In this case, the investigated period may be extended by the inclusion of solar cycles 19, 18 (the epoch of "increased" SA), 17 - the transition period from the epoch of "lowered" to the epoch of "increased" SA, and partly 16 (the epoch of "lowered" SA). During the transition period significantly increases the number of very large solar sunspot groups, occurs the most powerful solar flare events, including the largest solar proton events in the particles fluxes and can occurs violations of observational rules including the rule of heights alternation of even and odd solar cycles. Within the limits of epochs the established observational rules of sunspot-forming and flare activities can't be violated and all development of solar cycles goes according to similar schemes of the corresponding epochs.

Session 4 - Poster

Temporal variations of Solar and Interplanetary conditions for the last 4 decades

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There are many parameters representing the conditions of space environments. Those are modulated in general by Solar Cycle (SC) defined by sunspot number temporal variation. However, all parameters do not have same cyclic features. Thus, we compare the temporal variations of solar, interplanetary, geomagnetic (SIG) parameters with that of open solar magnetic flux from 1976 to 2014 (from Solar Cycle 21 to the increasing phase of Cycle 24) in order to identify the possible relationships. We investigate which component of solar magnetic multipoles best correlates with the SIG parameters. As results, the dynamic pressure of the solar wind is strongly correlated with the solar magnetic dipole flux, which varies in anti-phase with SC. Other solar activity indices such as the sunspot number, total solar irradiance, 10.7cm radio flux, and solar flare occurrence and highly correlated with quadrupole component. The geomagnetic activity represented by Ap index is correlated with higher order multipole components, which show relatively a lagged time variation with SC. Given these results, we suggest that the continuous observation of solar photospheric field and calculating the multipole components of the open solar magnetic field at the source surface may complement forecasting the geomagnetic activity intensity long term trend.

Session 1 - Speaker

Probing Solar Wind Turbulence with the Jansky Very Large Array

A. Kobelski (1), T. S. Bastian (2); 1 - National Radio Astronomy Observatory, Green Bank, WV, USA, 2 - National Radio Astronomy Observatory, Charlottesville, VA, USA

The solar wind offers an extraordinary laboratory for studying MHD turbulence, turbulent dissipation, and heating. Radio propagation phenomena can be exploited as probes of the solar wind in regions that are generally inaccessible to in situ spacecraft measurements. Here, we have undertaken a study with the VLA to observe point-like sources drawn from the JVAS catalog, and 3 VLA calibrator sources, to trans-illuminate the outer corona/inner solar wind. In doing so, we will exploit angular broadening and refractive scintillation to

deduce properties of the solar wind along ~100 lines of sight within 7 solar radii of the Sun and a wide range of position angles, a factor 10 improvement over previous studies. By fitting the complex visibilities using well-known techniques we can deduce or constrain a number of key parameters, including the spectral slope of the turbulence at both small (km to 10s of km) and large (thousands of km) scales, determine the presence and evolution of an inner scale, measure the degree of anisotropy, and constrain the topology of the global coronal magnetic field. The inner scale is of particular interest for constraining current theories of turbulence dissipation and heating.

Session 1 - Poster

Measuring the Solar Magnetic Field with STEREO A&B Faraday Rotation Observations using the 100m Green Bank Telescope

E. Jensen (1), C. Heiles (2), A. Kepley (3), **A. Kobelski** (3), D. Wexler (4); 1 - PSI, 2 - U. California Berkeley, USA, 3 - National Radio Astronomy Observatory, Charlottesville, VA, USA, 4 - Univ. of South Queensland, Australia

The STEREO A&B spacecraft recently passed through superior conjunction with the Sun due to their unique orbits. Measuring the accelerating solar wind from two relatively fixed points has not been possible since the early 1980's when the solar cycles were very different from today's unusually weak sunspot cycles. We have taken measurements with the 100m Green Bank Telescope to measure the Faraday rotation of STEREO A's radio frequency carriers to investigate the magnetic field of the solar corona at various radial distances and within different structures, specifically the quiet background, magnetohydrodynamic fluctuations, and coronal mass ejection crossings. These observations show notable fluctuations in the Faraday rotation of the signal, allowing a unique insight into the dynamics of the above 1.7 Solar radii.

Session 5 - Poster

Solar Observations with the Atacama Large Millimeter/ submillimeter Array (ALMA)

The ALMA Solar Development Team: T. S. Bastian (NRAO), M. Bárta (Ondřejov), R. Brajša (Zagreb), B. Chen (CfA), B. De Pontieu (LMSAL), G. Fleishman (NJIT), D. Gary (NJIT), A. Hales (NRAO), R. Hills (MRAO), H. Hudson (UCB), G. Hurford (UCB), K. Iwai (NAOJ), **A. Kobelski** (NRAO), S. Krucker (UCB), M. Shimojo (NAOJ), I. Skokic (Zagreb), S. Wedemeyer (Oslo), S. White (AFRL), Y. Yan (CAS)

The Atacama Large Millimeter/Submillimeter Array (ALMA) is a joint North American, European, and East Asian project that opens the mm-sub mm wavelength part of the electromagnetic spectrum for general astrophysical exploration, providing high-resolution imaging in frequency bands currently ranging from 84 GHz to 950 GHz (300 microns to 3 mm). Despite being a general purpose instrument, provisions have been made to enable solar observations with ALMA. Radiation emitted at ALMA wavelengths originates mostly from the chromosphere, which plays an important role in the transport of matter and energy, and the in heating the outer layers of the solar atmosphere. Despite decades of research, the solar chromosphere remains a significant challenge: both to observe, owing to the complicated formation mechanisms of currently available diagnostics; and to understand, as a result of the complex nature of the structure and dynamics of the chromosphere. ALMA has the potential to change the scene substantially as it serves as a nearly linear thermometer at high spatial and temporal resolution, enabling us to study the complex interaction of magnetic fields and shock waves and yet-to-be-discovered dynamical processes. Moreover, ALMA will play an important role in the study of energetic emissions associated with solar flares at sub-THz frequencies.
In this paper we describe recent efforts to ensure that ALMA can be usefully exploited by the scientific community to address outstanding questions in solar physics. We summarize activities by the ALMA solar development team comprised of scientists from the East Asia, North America, and Europe. These activities include instrument testing, development of calibration and imaging strategies, software requirements development,

and science simulations. Opportunities for the wider community to contribute to these efforts will be highlighted.

Session 2 - Poster

Comparison of detection and tracking methods of CME fronts in sequences of satellite coronograph images

Z. Kobyliński, J. Biały, T. Seredyn, Polish Air Force Academy, Dęblin, Poland

The standard procedure of the detection and tracking of the CMEs from the middle to the outer corona is the visual valuation and then preparing height – time profiles of the CMEs. The CME height at any given instant is calculated from the outermost point of the front edge to the heliospheric center in the snapshots of CME images. Several attempts of CME images analyzing have been made in order to use in a system of automatic CMEs detection using digital image processing methods. We compare the following edge detectors: Roberts, Prewitt, Sobel, LoG, Canny and Multiscale Edge Detection Technique by Young and Gallagher, using them to analyze several sequences of LASCO C2/C3 CME images and one TRACE image from the last solar cycle. We have found that Canny method is the best detector for extraction of CME front edges. After obtaining the front edges it is possible to study structure and evolution of CMEs in the broad spectrum of directions as it is seen from the showed images. Obtained plots of height – time and values of mean velocities in every case are presented.

Session 4 - Poster

Solar cycle 25 forecast using Elman recurrent networks

Z. Kobyliński (1), A. Wysokiński (2), T. Seredyn (1); 1 - Polish Air Force Academy, Dęblin, Poland; 2 - Independent researcher, Iganie, Poland

The forecast of the parameters of the solar cycle is significant for planning satellite launching, as large eruptions of solar plasma and solar cosmic rays can cause damage and malfunction of satellite and aircraft electronics and health hazards in space, as well as can spoil radio-based communication and navigation systems. Many methods have been developed to predict the amplitude of solar maximum, duration and shape of the 24 solar cycle. They have changed from simple statistical to complex physical, as for example geomagnetic precursor, based on the understanding of the dynamo process that generates the solar magnetic field and its evolution. The big disaccord of prediction results could be pointed out. The purpose of the paper is to calculate the Wolf numbers and areas of sunspot groups progression during the next 25th solar cycle basing on the earlier cycles data by means of the artificial neural networks (ANN). We focus our attention on Elman ANN because comparisons of ANN type effectiveness in modeling of disturb course of different geomagnetic parameters indicated on an recurrent ANN as better predictor than equivalent feed-forward ANN. We use daily data of the Wolf numbers and areas of sunspot groups from 1916 till Jun 2015 averaged by Bartels rotations and monthly green coronal line data from 1939. Accordingly to our estimations the duration of the rise phase the 25th solar cycle would be about 4 years, and generally the next solar maximum would be rather low similarly to the 24th cycle.

Session 1 - Speaker

A study of a quiet solar network region structure and dynamics using ground and space based observations

I. Kontogiannis, G. Tsiropoula, K. Tziotziou (National Observatory of Athens) and C. Gontikakis (Academy of Athens)

We present a detailed study of a very quiet solar region, using data from an observational campaign that involved ground based and space born instruments. The region was observed by the Dutch Open Telescope, the XRT, SOT and EIS instruments onboard Hinode, TRACE and the MDI onboard SoHO. This combination of instruments offers a complete tomographic view of the atmospheric layers from the photosphere to

the corona and allows a) the determination of its magnetic and temperature structure b) the correspondence between fine structure and jet-like events at different atmospheric heights c) the study of wave propagation through the atmospheric layers. A calculation of the current-free magnetic field vector up to the corona shows that the network structure persists up to coronal temperatures and consists of a multitude of flux tubes that connect to different network and internetwork areas and reach different heights and temperatures. At least some of the jet like structure s observed in the Hα line, around the network, have a counterpart in the overlying atmosphere. We study their evolution in the different atmospheric heights/temperatures. We also determine the height of the magnetic canopy, the interface between the completely magnetized plasma of the chromosphere/transition region and the underlying photosphere. The distribution of the power of the acoustic oscillations and its dependence on the inclination of the magnetic field shows that, at the height of the magnetic canopy, acoustic waves undergo conversion and transmission. This finding is also supported by the measured phase differences between oscillations at different heights. Fast waves reflect at the turning height and form standing waves while slow waves propagate along the slanted magnetic field lines of the network.

Session 5 - Poster

Integrating ground-based and space-born observations to create a new space weather facility at the National Observatory of Athens

I. Kontogiannis, A. Belehaki, G. Tsiropoula, I. Tsagouri, A. Anastasiadis,
A. Papaioannou (IAASARS, National Observatory of Athens, Penteli, Greece)

We describe a new space weather facility implemented at the Institute of Astronomy Astrophysics, Space Applications and Remote Sensing (IAASARS) of the National Observatory of Athens (NOA). The facility aims to provide observations, processed data and space weather nowcasting and forecasting products, designed to support the space weather research community and operators of commercial and industrial systems, as a part of the PROTEAS project. To this end, the following ground-based and space-borne observations as well as model results and tools are integrated: a) chromospheric imaging in Ha by a small full-disk solar telescope in regular basis; b) a prediction tool for forecasting Solar Energetic Particles (SEPs) in relation to solar eruptive events; c) real time monitoring of ionospheric conditions by the upgraded Athens Digisonde; d) a database with near real-time solar observations which will be available to the community through a web-based facility (HELIOSERVER); e) additional data sets from the European Digital Upper Atmosphere Server (DIAS) integrated in an interfa ce with the HELIOSERVER and with improved models and techniques for the real-time quantification of the effects of solar eruptive events in the ionosphere. Science cases that demonstrate the expanded capabilities of the facility are also presented.

Session 1 – Poster

Evolution of ARs at photosphere before flare and CME occurrence

M. Korsós, SP2RC, University of Sheffield, UK

We propose the introduction of new measures of pre-flare and pre-CME behaviour of by analysing the evolution of active regions using the Debrecen Sunspot Data catalogue. The proxy measure of our approach is the so-called weighted horizontal gradient of magnetic field (WGM) defined between spots of opposite polarities closer to the neutral line of an AR. The value and the temporal variation of WGM is found to possess novel, very interesting and potentially important diagnostic information about (i) the intensity of expected flares, (ii) the accuracy of onset time prediction, and (iii) whether a flare, with same energetic class in terms of the GOES classification, is followed by another one within 18 hours.
We also suggest the introduction of further two parameters characterising ARs for warning purposes for pre-flare and CME prediction and follow-up monitoring. One is the so-called daily average of the horizontal magnetic gradient (GDS) and the other is the

separation parameter (Sl-f). These pre-cursor parameters seem to be useful in practice by means of estimating the level of separation of opposite polarities in ARs. By comparing their temporal variation before 24 (or even up to 48) hours prior to flare event one can reliably assess (within errors) the risk of an associated CME.

Session 1 - Speaker

On measurements of continuum flux in solar flares. Instrument and first results

P. Kotrč (1), P. Heinzel (1), O. Procházka (1,2), 1 - Astronomical Institute of the Academy of Sciences of Czech Republic, Ondřejov, CR, 2 - Faculty of Mathematics and Physics, Charles University, Prague, CR

For a broad-band diagnostics of chromospheric flare plasma is highly desirable to analyze spectra covering many spectral lines and various continuum features. The flare spectra in UV are well detected on the weak background radiation of the solar disk. Detection of flare continuum from the Sun-as-a-star in optical is much more difficult due to a strong background radiation. Knowledge of flare continuum flux or continuum intensity could be a clue parameter for contemporary models and role of accelerated particles. Supposing the flare/background radiation contrast is strong enough to be detected, we developed a device for measuring spectral flux from a selected part of the flaring region. Here we present a technical description of the post-focus instrument installed at the horizontal solar telescope HSFA2 of the Ondřejov observatory. It consists of a system of diaphragms, imaging Hα telescope and a fast spectrometer for measuring flux in 350 - 430 nm with dispersion of 3 px per Angstroem but with cadence reaching up to 50 frames per second. To measure both Balmer and Paschen continua simultaneously, a new spectrometer with even a lower dispersion was installed recently. The first solar flares observed by this novel technique provide quite interesting results which are presented.

Session 1 - Poster

Analysis of a limb eruptive event

P. Kotrč (1), W. Liu (1), Y. Kupryakov (1,2), M. Bárta (1), L. Kashapova (3);
1 - Astronomical Institute AS CR Ondřejov, Czech Republic, 2 - Moscow Lomonosov University, Moscow, Russia, 3 - ISTF AS RF Irkutsk, Russia

Limb eruptive events give a good possibility to interpret spectra and filtergrams from a more simple geometric consideration. We present analysis of an eruptive event took place on the eastern limb on April 21, 2015 which was observed by the Ondrejov horizontal telescope and spectrograph. The eruption of the highly twisted prominence was followed by onset of soft X-ray source. We identified the structures observed in H-alpha spectra with the details on the filtergrams and analysed evolution of Doppler component velocities. The timing and observed characteristics of the eruption were compared with prediction of model based on the twisting of the ropes and the kink instability.

Session 5 - Poster

The CoMP-S instrument at the Lomnicky Peak Observatory - status report

A. Kučera, J. Ambróz, P. Gömöry, P. Habaj, J. Kavka, M. Kozák, P. Schwartz, J. Rybák (Astronomical Institute, Slovak Academy of Sciences, Tatranská Lomnica, Slovakia), S. Tomczyk, S. Sewell, P. Aumiller, R. Summers, L. Sutherland, A. Watt (High Altitude Observatory, The National Center for Atmospheric Research, Boulder, USA)

The Coronal Multi-channel Polarimeter for Slovakia (CoMP-S) has been installed at the high-altitude Lomnicky Peak Observatory of the Astronomical Institute of SAS (2633 m a.s.l.) in 2011. The instrument was designed and manufactured by HAO/NCAR (Boulder, USA) with a tunable Lyot filter and polarimeter for visible and near IR spectral regions.

This instrument is proposed for coronagraphic observations of magnetic and velocity fields in the solar corona and in prominences. A fundamental upgrade of this instrument has been prepared with pair of cameras sensitive in the near IR spectral region in a new camera module. This upgrade is being incorporated to the instrument in course of the year 2014. In this contribution the technical parameters of the final configuration the CoMP-S instrument containing four cameras, covering both visible and near IR spectral regions, are described. We also present a potential of the CoMP-S instrument for coronagraphic spectro-polarimetric observations of the solar corona and prominences with a capability for sequential measurements of the spectral profiles of all prominent emission lines in spectral region from 500 to 1100 nm.

Session 1 - Invited Speaker

Quiet sun magnetism: a new perspective from GRIS / GREGOR

A. Lagg and the GREGOR/GRIS Team, Max Planck Institute for Solar System Research, Göttingen, Germany

The amount of magnetic flux, the field strength and its angular distribution in internetwork regions in the solar photosphere is a controversial topic in the literature. The reason for the controversy lies in the difficulty of measuring these quantities: Zeeman effect based measurements suffer from signal cancellation of oppositely directed, unresolved fields and the different sensitivity to longitudinal and transversal fields. Hanle effect based measurements require highly accurate spectropolarimeters and a good modelling of the depolarization mechanisms. In this review I will present the status of this controversial discussion as well as new results originating from high-resolution spectropolarimetric measurements in the magnetic highly sensitive Fe I 1.56 micron lines obtained with the infrared spectrograph GRIS at the GREGOR telescope.

Session 3 - Invited Speaker

Modeling the Mg II h & k lines observed by IRIS and the Ca II H & K lines observed from the ground

J. Leenaarts, Institute for Solar Physics, Stockholm University, Stockholm, Sweden

The Mg II h & k and Ca II H & K lines have similar formation properties. Their main difference is the 18 times larger abundance of Mg compared to Ca. This leads to a significant height difference of the line-core optical-depth-unity-heights. I will review the formation of the Ca and Mg lines, and discuss their diagnostic potential, in particular if observed simultaneously.

Session 1 - Poster

Exploring the diagnostic value of Helium I D3 in the chromosphere

T. Libbrecht, J. de la Cruz Rodriguez, Institute for Solar Physics, Stockholm University, Stockholm, Sweden

We present high-resolution observations of the chromospheric He I D3 line at 5876 Å, with SST/TRIPPEL and SST/CRISP. The SST observations have the highest spatial and spectral resolution for He I D3 up till date, and our goal is to explore its diagnostic value in the upper chromosphere.
The lower level of D3 gets populated via the photoionization-recombination mechanism. Therefore, the line intensity is sensitive to EUV-radiation from the corona and from the transition region. We investigate the He I D3 line behaviour for different targets on the sun: flares, active regions, plages, off-limb, ... and we interprete the spectra in context of space-borne co-observations with IRIS and SDO. Moreover, the He I D3 line is magnetically sensitive and allows for high-resolution spectro-polarimetric observations with SST/CRISP. We will present preliminary results of inversions of the He I D3 line with the inversion code HAZEL, to obtain the full magnetic field vector in the upper chromosphere.

Session 2 - Invited Speaker

A comparison of solar image restoration techniques for SST/CRISP data

M. Löfdahl, Institute for Solar Physics, Stockholm University, Sweden

Solar images from high-resolution, ground-based telescopes are corrected for the blurring effects of atmospheric turbulence by adaptive optics and image restoration. Two classes of image restoration methods are regularly used today, those based on multi-frame blind deconvolution and those based on speckle interferometry. In a recently started project, we will compare and evaluate such methods for use with spectropolarimetric data from SST/CRISP. During this presentation, I will describe the two methods and our results so far.

Session 3 - Speaker

Probing the Sun with ALMA: observations and simulations

M. Loukitcheva (Saint-Petersburg State University, Russia), S. K. Solanki (MPS, Germany), S. White (AFRL, US) and M. Carlsson (Institute of Theoretical Astrophysics, Norway)

Atacama Large Millimeter/Submillimeter Array (ALMA) will open a new chapter in the study of the Sun by providing a leap in spatial resolution and sensitivity compared to currently available millimeter wavelength observations. In preparation of ALMA, we have carried out a large number of observational tests and state-of-the-art radiation MHD simulations. Here we review the best available observations of the Sun at millimeter wavelengths focusing on the quiet solar chromosphere and sunspots. Using state of the art radiation MHD simulations of the solar atmosphere we demonstrate the huge potential of ALMA observations for uncovering the nature of the solar chromosphere. We show that ALMA will not only provide a reliable probe of the thermal structure of the chromosphere, it will also open up a powerful new diagnostic of magnetic field at chromospheric heights, a fundamentally important, but so far poorly known parameter.

Session 5 - Poster

Solar Radio Observation using Callisto Spectrometer at Sumedang West Java

T. Manik, **P. Sitompul**, M. Batubara, T. Harjana, C. Y. Yatini (Space Sience Center of LAPAN, Indonesia), C. Monstein (Institute of Astronomy, ETH Zurich, Switzerland)

Sumedang Observatory (6.91° S, 107.84° E) was established in 1985 as one of solar observation facility of Space Science Center of Indonesian National Institute of Aeronautics and Space (LAPAN), located around 40 km, East part of Bandung City, West Java, Indonesia. Several instrumentations for solar and space observation such as optical telescopes, radio solar spectrograph, flux gate magnetometer, etc. are operated there, then an ionosphere sounding system (ionosonde) was also setup later. In July 2014, a standard Callisto (Compound Astronomical Low-cost Low-frequency Instrument for Spectroscopy and Transportable Observatory) spectrometer was installed at Sumedang Observatory for solar radio activity monitoring. Callisto spectrometer has observation capability in the frequency range of 45-870 MHz. The Callisto spectrometer receives signal by using a set of 21 elements log-periodic antenna, model CLP5130-1N, pointed to the sun and equipped with a pre-amplifier. With consider to Radio Frequency Interferences (RFI) measurement which conducted previously, Callisto spectrometer is operated on frequency ranges of 45-80 MHz and 180-450 MHz, individually. Observation status and data flow are monitored in on-line from center office located in Bandung. The data are transferred to central database at FHNW (Fachhochschule Nordwestschweiz) server every 15 minutes to be appears on e-Callisto network subsequently. A real time data transfer and data processing based on Python software also has been developed successfully to be used as a value input for space weather information and forecasting services (SWIFtS) provided by LAPAN. On 5th November 2014, Callisto spectrometer at Sumedang observed the first clear solar radio event, a solar radio burst type II

corresponds to CME, indicated by a strong x-ray event of M7.9 that was informed on by Space Weather Prediction Center (SWPC) NOAA. Thereafter, Callisto spectrometer at Sumedang also observed several solar radio burst in various types. This paper describes the system configuration of Callisto spectrometer installed at Sumedang, RFI measurement and chosen observation strategy, conducted real time data transfer and processing, several samples of present result of solar radio burst monitoring at Sumedang, and future development plan of Callisto spectrometer in Indonesia which will be able to cover 14 hours of day solar observation.

Session 1 - Speaker

Radial Evolution of Coronal Mass Ejections in the Inner Heliosphere

P. K. Manoharan, Radio Astronomy Centre, National Centre for Radio Astrophysics, Tata Institute of Fundamental Research, India

Coronal mass ejections (CMEs) are the most energetic events associated with the eruption of plasma and magnetic field from the Sun and they drive solar wind disturbances, accelerate particles to high energies, and contribute to space weather phenomena affecting the near-Earth environment, e.g., severe geo-magnetic storms. In understanding the range of space weather effects of a CME, the knowledge of the radial evolution of the CME is important for the determining of its arrival at the near-Earth space and for inferring of its interaction with the disturbed/ambient solar wind in the course of its travel to 1 AU and further. The interplanetary scintillation (IPS) technique provides an essential tool to track CMEs and their associated disturbances in the Sun-Earth distance, and it has demonstrated the ability to make correct association between CMEs and their effects at the Earth's environment. The IPS measurements at 327 MHz obtained from the Ooty Radio Telescope (operated by the National Centre for Radio Astrophysics, Tata Institute of Fundamental Research, India) are capable of providing estimates of solar wind speed and density turbulence along directions of a large number of radio sources (~1000 sources per day) in the heliospheric distance range of 20 - 250 solar radii. This talk will review results on the radial evolution of CMEs based on the large IPS database collected from the Ooty Radio Telescope. Additionally, the solar wind estimates along different cuts of the heliosphere allow the reconstruction of three-dimensional structures of propagating transients in the inner heliosphere. The results on three-dimensional evolution of size and speed of solar wind transients (e.g., propagating CMEs as well as co-rotating interaction regions (CIRs)), are reviewed and discussed on the possibility of forming a basic model to forecast the arrival/impact of solar and solar wind generated space weather effects at the Earth or else where.

Session 4 - Poster

Three-dimensional Evolution of Solar Wind during Solar Cycles 22-24

P. K. Manoharan, Radio Astronomy Centre, National Centre for Radio Astrophysics, Tata Institute of Fundamental Research, India

We present results on the three-dimensional evolution of solar wind density turbulence and speed at various levels of solar activity between solar cycles 22 and 24. The solar wind data used in this study has been obtained from interplanetary scintillation (IPS) measurements made at the Ooty Radio Telescope, operating at 327 MHz. Comparison of results at corresponding phases of solar cycles reveals that on the average, there is a downward trend in density turbulence from the maximum of cycle 22 to the present phase of cycle 24. In particular, in the present state of reduced solar activity, slow speed dominates the large part of heliosphere and there is a reduction in the supply of mass and energy at the base of the corona and into the heliosphere. Moreover, the latitudinal distribution of solar wind speed has been significantly different during the above period. I will also discuss the results on the radial dependence of solar wind properties (level of turbulence, spatial cut-off scales, etc.) at representative periods of solar cycles 22 to 24.

Session 4 - Speaker

Co-variability of the atmospheric and geophysical parameters in mid-latitude troposphere

A. Morozova (1), J. J. Blanco (2), P. Ribeiro (1); 1 - CITEUC - Centre for Earth and Space Research of the University of Coimbra, Almas de Freire, Sta. Clara, Coimbra, 3040-004, Portugal; 2 - University of Alcalá, Pza. San Diego, s/n - 28801 Alcalá de Henares, Madrid, Spain

The Principal Component Analysis (PCA) of meteorological parameters (air pressure and geopotential heights) at different pressure levels in troposphere and tropopause regions allows to extract components which strongly resemble variations of the cosmic rays (CR) and geomagnetic field. The study is based on the locally measured parameters (atmospheric, cosmic rays and geomagnetic) at the mid-latitudes (Spain and Portugal). The results of the analysis allow us to make two conclusions.
At first, the methods used to correct the ground measured cosmic ray flux (measured by the neutron monitors) for the atmospheric depth variations based on the ground measured air pressure variations do not permit to fully exclude the atmospheric components from the measured CR variations. The corrected for pressure and efficiency data still contain an information on the long-term (with characteristic period from weeks to months) variations of the pressure (and temperature as well) of the top troposphere-tropopause (and probably, stratosphere) region.
Secondly, the short-term (with characteristic period from days to weeks) variations of the atmospheric parameters show similarities with the variations of the geomagnetic field on the same time scale. These variations can be observed at most of the tropospheric pressure levels. No significant co-variability was found between these short-term atmospheric modes and CR flux changes.

Session 5 - Invited Speaker

Solar Orbiter - Exploring the Sun-Heliosphere Connection

D. Müller, ESA-ESTEC, Noordwijk, The Netherlands

Solar Orbiter, the first mission of ESA's Cosmic Vision 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. This talk will 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.

Session 2 - Invited Speaker

The effects of instrumental properties on Stokes Inversions

M. van Noort, Max Planck Institute for Solar System Research, Göttingen, Germany

Since the first inversion codes appeared more than two decades ago, Stokes inversions have become an indispensible tool for the interpretation of solar spectro-polarimetric data. Although qualitatively much has been learnt from the results, the quantitative analysis of solar properties has remained considerably more ellusive, due to large uncertainties in the reliability of the results. Degradation of the data by instrumental effects and contamination of the data by stray-light, contribute strongly to this uncertainty. In this talk, I will discuss ongoing efforts towards improving this situation, by including a more complete formation model of the data, and a consistent treatment of stray-light.

Session 5 - Speaker

MiHI: a new imaging spectrograph

M. van Noort, Max Planck Institute for Solar System Research, Göttingen, Germany

As part of the EU FP7 project SOLARNET, we are developing a prototype of a new type of imaging spectrograph for solar observations. The Microlensed Hyperspectral Imager (MiHI), consists of a double microlens array, that is able to produce an array of point sources, suitable for dispersion by a spectrograph, but without spoiling the pupil image on the grating, without scanning and without masking. The instrument will be intrinsically very photon-efficient, and will be able to record high-cadence spectral and image information strictly simultaneously over a 7x7 arcsec FOV. A prototype of this instrument, containing 128x128 image elements and 324 spectral elements per image element, is currently under construction.

Session 4 - Poster

Relationship between Variation of Total Ozone Concentration and Severe Geomagnetic Storms over Lagos in Nigeria

E. C. Okoro and F. N. Okeke (Department of Physics and Astronomy, University of Nigeria, Nsukka, Nigeria)

This paper presents the significant relationship between total ozone concentration and severe geomagnetic storm index over Lagos state (06.600N 03.330E), Nigeria. Analyses show that there is a significant and persistent response of total column ozone to severe geomagnetic storms. This occurred only in wet season, and under high solar activity maximum/East phase Quasi Biennial Oscillation (QBO) conditions. Furthermore, it was observed that the total column ozone response to major geomagnetic storms appears to be caused by changes in QBO, which is part of atmospheric dynamics. Invariably, this shows that changes of circulation pattern agree qualitatively with changes in total column ozone. Also, the seasonal variation of ozone column in the low latitude (Lagos) followed a definite pattern, indicating maximum amplitude between July and September and minimum amplitude between December and February. Analyses show weak correlation relationship between sunspot number and ozone column almost throughout the year under study, except for 1998 and 2000. This indicates that a different precursor could be responsible for ozone variations in Lagos, Nigeria.

Session 4 - Speaker

Are we on the verge of a Maunder-like Grand Solar Minimum?

J. Padmanabhan, Physical Research Laboratory, Ahmedabad - 380009, India;
S. K. Bisoi, Physical Research Laboratory; Ahmedabad - 380009, India,
S. Ananthakrishnan, Department of Electronic Science, University of Pune,
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Several studies in recent times have reported that solar high latitude fields have been steadily declining since around 1995. The previous solar cycle 23 has also been unusual in that, it experienced one of the deepest solar minima in the past 100 years with over 70% of the days in 2007 and 2008 being entirely spotless. We have made a detailed study of the effect of such a steady and prolonged decline in solar photospheric magnetic fields on the solar wind using interplanetary scintillation (IPS) observations of solar wind micro-turbulence levels. Our study, of solar photospheric magnetic fields covering solar cycles 21, 22 and 23, has shown a steady decline in magnetic fields at latitudes above 45 degrees in both solar hemispheres and has also shown a steady decline in solar wind micro-turbulence levels, in the distance range 0.2 to 0.8 AU, in sync with the declining solar photospheric fields. These results beg the question as to whether we are headed towards a long period of little or no sunspot activity, in a manner similar to the period between 1645 and 1715 known as the Maunder minimum, when the sun was completely devoid of sunspots. We have estimated the expected sunspot number around the maximum of solar cycle 25 and find that cycle 25 will be much weaker than the current

cycle 24 which had a peak sunspot number in November 2013 of around 75 in November 2013. We have also looked for signatures of the declining solar wind micro-turbulence levels in the Earth's ionosphere and our study indicates that the night time ionospheric cut-off could reduce to well below 5 MHz if the decline in the solar magnetic fields continues beyond 2020.

Session 2 - Speaker

Solar eruptive events as seen by the Spanish Space Weather Service SeNMEs

J. Palacios and the SeNMEs team, Universidad de Alcalá (UAH), Madrid, Spain

The Spanish Space Weather Service SeNMEs is a portal created by the SRG-SW of the University of Alcalá, Spain, to meet societal needs of near real-time space weather services. This webpage-portal is divided in different sections to fulfill users' needs about space weather effects: radio blackouts, solar energetic particle events, geomagnetic storms and presence of geomagnetically induced currents.
In less than one year of activity, this service has released a daily report concerning the solar current status and interplanetary medium, informing about the chances of a solar perturbation to hit the Earth's environment. There are also two different forecasting tools for geomagnetic storms, and a daily ionospheric map. These tools allow us to nowcast a variety of solar eruptive events and forecast geomagnetic storms and their recovery, including a new local geomagnetic index, LDiñ, along with some specific new scaling.
In this communication we emphasize some eruptive events that were actually missed or mistaken by other space weather services. Using different high resolution and cadence data from space-borne solar telescopes SDO, SOHO and GOES, we are achieving the goal of nowcasting solar events.

Session 2 - Poster

Multi-wavelength observations of vortex-like flows in the photosphere from ground-based and space-borne telescopes

J. Palacios (Universidad de Alcalá (UAH), Madrid, Spain), S. Vargas Domínguez (Universidad de Los Andes, Colombia), L. A. Balmaceda (ICATE-CONICET, Argentina), I. B. Cabello García (ICATE-CONICET, Argentina), V. Domingo (Universitat de Valencia, Spain)

Following a series of papers on these observations (Balmaceda et al. 2009, Balmaceda et al. 2010, Vargas Dominguez et al 2011, Palacios et al. 2012, Vargas Domínguez et al 2015, Cabello et al., in preparation), utilizing several long multi-wavelength data series. These were acquired from both ground-based (SST) and space-borne (Hinode) high-cadence and high resolution data, including SOT-SP data, in a joint campaign of the Hinode Operation Program 14, in Sept 2007. Diffraction-limited SST data, taken in G-band and G-cont, were restored by MFBD, whilst Hinode obtained multispectral data from SOT-FG in CN, Mg II, Ca II and also SP in Fe I lines. In these series we have thoroughly studied vortex flows and their statistical occurrences, horizontal velocities by local correlation tracking (LCT), divergence and vorticity; but we also have studied bright point statistics and magnetic field intensification, clearly highlighting the importance of the smallest-scale magnetic element observations.

Session 4 - Poster

New Software for Space Weather

Y.-d. Park, Korea Astronomy & Space Science Institute (KASI), Daejeon, KOREA

KASI have been constructed the Space Weather Center in 2007 and contributed to the R&D of Korean space weather. Particularly we installed the SDO data center for Asia region as well as VAP(Van Allen Prove) satellite data receiving system which are twin satellites launched in 2012 by NASA for the radiation belts (Van Allen Belt) observation. We developed the software for those data analysis as the name of "Haebogi" and "RBA

(Radiation Belts Analyst)" Habogi is similar to the "JHelioviewer" but it developed stronger to analysis the SDO data from KASI data center. RBA is excellent data analysis software for radiation belt observed data taken from VAP even though it is heavy a little bit. We will upgrade those program continuously and hope to those S/W contribute space weather research of the world.

Session 3 - Speaker

Meridional circulation dynamics: comparing observations and results from EULAG global 3D MHD simulations

D. Passos (CENTRA-IST, Portugal and University of Montreal, Canada)

As time progresses, Helioseismology is being able to peer into the deeper layers of the solar convection almost to tachocline depth. While differential rotation is well mapped in radius and latitude, the mapping of the meridional circulation (MC) profile (a much slower large scale flow) still presents a challenge to current measurement methodologies. A clear sign of these difficulties is the different profiles obtained by different groups (especially in depth). This weak large scale flow is one of the key ingredients in current solar dynamo theories and its temporal behavior and spatial morphology has a large impact in the modeling of the large scale magnetic field responsible for the solar cycle. Dynamo modelers try their best to incorporate the constraints imposed by observations but the shape of the MC has been a subject of debate (given the lack of observational data). Besides that, only in the last 5 years or so, the temporal variation of the amplitude of the MC has been incorporated into mean-field dynamo models. The complete temporal and spatial profile of the MC is therefore something very important for mean-field dynamo modeling.
A complementary (and more recent) way of modeling the solar dynamo is through global 3D MHD simulations of solar convection. These type of simulations are now starting to provide some answers about how the MC forms and how it is influenced by magnetic fields. In this talk I will present a comparison between the observational characteristics of the MC and a recent study based on a global MHD simulation of solar convection performed with the EUALG-MHD code. This study shows that the amplitude modulation of the MC (at certain depths) can be explained by angular momentum transfers mediated by the magnetic field. This result, when (if) confirmed by other groups, should have a profound impact in the way current mean-field dynamo models are implemented, i.e. the ubiquitous kinematic regime used can no longer be considered the best approximation to run these models since it is skipping important dynamic behaviors.

Session 1 - Poster

The chromosphere as imaged in O I 777.2 nm

H. Pazira, D. Kiselman, Stockholm University, Stockholm, Sweden

We have observed the strongest line in the IR triplet of neutral oxygen 777.2 nm using SST/CRISP. The aim is to better understand the formation of this line and its possible use for chromospheric diagnostics. We investigate the emission outside the solar limb. The observations are compared with synthetic spectra computed for different FAL atmospheric models using the RH code. So far, our results suggest that the off-limb emission follows the variations of the line opacity which is very temperature sensitive. Regions with low emission, like a dark gap often seen close to the limb, thus indicate cooler temperatures.

Session 1 - Speaker

Clashing views of spicules and fibrils

T. M. D. Pereira et al. - Institute of Theoretical Astrophysics, University of Oslo, Norway

Solar spicules are chromospheric fibrils observed at the solar limb. These thin, jet-like structures are ubiquitous but their origin is not yet understood. They are a challenge to observe and to model, yet have been the subject of a heated discussion regarding their

possible role in supplying mass and energy to the corona. Are they real mass motions or just a consequence of magnetic tangential discontinuities? Why do they appear in filtergrams, and what sets them apart from the bulk of chromospheric fibrils? Here I will show recent high-resolution observations from the Swedish Solar Telescope (SST) coordinated with the Interface Region Imaging Spectrograph (IRIS), showing spicules in great spatial detail and across multiple diagnostics. I will discuss what sets spicules apart from other fibrils, how they are most likely mass motions, and how the latest observations can be used to constrain models and place us a little closer to solving this chromospheric puzzle.

Session 1 - Invited Speaker

The need for synoptic solar observations from the ground

A. A. Pevtsov, National Solar Observatory/Sacramento Peak, Sunspot, USA

Synoptic observations are indispensable in studies of long-term effects pertinent to variation in solar radiative output, space weather and space climate, as well as for understanding the physics of global processes taking place on our nearest star. Synoptic data also allow putting the Sun in the context of stellar evolution. Historically, the main-stay of such observations has been ground-based although the improving longevity of space-borne instruments puts some space missions into the category of synoptic facilities. Space- and ground-based (synoptic) observations are complementary to each other; neither is inferior or superior to the other. Ground-based facilities can have a long-term (50 years+) operations horizon, and in comparison with their space-based counterparts, they are less expensive to operate and have fewer restrictions on international collaboration and data access. The instruments can be serviced, upgraded, and cross-calibrated to ensure the continuity and uniformity of long-term data series. New measurements could be added in response to changes in understanding the solar phenomena. Some drawbacks such as day-night cycle and the variable atmospheric seeing can be mitigated e.g., by creating the global networks and employing the adaptive optics. Furthermore, the ground-based synoptic observations can serve as a backbone and a back-up to space-based observations.
In my talk I will review some existing ground-based synoptic facilities, describe plans for future networks, and outline the current efforts in strengthening the international collaboration in synoptic solar observations from the ground.

Session 3 - Poster

X-ray emission in simulations of flaring coronal loops

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Solar flares are associated with intense X-ray emission generated by hot flaring plasma and by energetic particles in coronal magnetic loops. We investigate the temporal, spatial and spectral evolution of the properties of the X-ray emission produced in simulated kink-unstable magnetic flux-ropes (using MHD and test-particle methods). The numerical setup used consists of highly twisted loops embedded in a region of untwisted background coronal magnetic field. The magnetic flux-rope reconnects with the background flux after the triggering of the kink instability and is then allowed to relax to a lower energy state. Strong ohmic heating leads to strong and quick heating (up to more than 15 MK), to a strong peak of soft X-ray emission and to the hardening of the thermal X-ray spectrum. Particles are accelerated in all the flaring loop volume, but the associated synthetic hard X-ray emission is nevertheless concentrated near the footpoints. The amount of twist deduced from the thermal X-ray emission alone is considerably lower than the maximum twist in the simulated flux-ropes. The flux-rope plasma becomes strongly multi-thermal during the flaring episode, and the emission measure evolves into a bi-modal distribution as a function of temperature during the

saturation phase, and later converges to the power-law distribution during the relaxation/cooling phase.

Session 4 - Speaker

The slow and fast solar wind during the activity cycle

R. F. Pinto, A. Rouillard; IRAP, University of Toulouse, OMP/CNRS, Toulouse, France

The cyclic variations of the strength and geometry of the global background magnetic field strongly affect the solar wind flow and cause the segregation between the fast and slow wind flows. Fast wind flows develop exclusively within coronal holes, while the slow solar wind streams from the vicinities of the coronal hole boundaries (i.e, around streamers and pseudo-streamers) and/or active regions. Besides, the fast and slow wind components display different acceleration profiles, types of oscillations/waves, and ion composition, despite the respective wind heating and acceleration mechanisms being probably similar.
We investigate these problems jointly by performing numerical simulations of the corona and solar wind covering an 11 yr activity cycle. The wind speeds we obtained are in agreement with in-situ measurements (ULYSSES) and radio maps (IPS). The wind speeds at all latitudes and moments of the cycle depend on two simple parameters (related to the flux-tube amplitude and inclination), in addition to the traditional expansion ratios in the WSA law commonly used in space weather applications. These results were tested using different heating scenarios. We also found that the calculated Alfvén radii and the global Sun's mass loss rate vary considerably throughout the cycle (by a factor 4.5 and 1.6, respectively), leading to strong temporal modulations of the global angular momentum flux and magnetic braking torque, which has implications for the more general stellar wind spin-down.
This is work is supported by the FP7 project #606692 (HELCATS).

Session 1 - Speaker

Origin of the 30 THz emission during the 2012 March 13 solar flare at 1720 UT

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Solar observations in the infrared domain can bring important clues on the lower layers of the solar atmosphere and on their response to primary energy released during flares. The 10 micron (30 THz) observations of the flare SOL2012-03-13 recently presented and discussed in Kaufmann et al. (2013), is one of the few examples in the literature. However, no firm conclusions are drawn on the origin of the mid-infrared radiation. In this work we present a detailed multi-frequency analysis of SOL2012-03-13, including observations in radio millimeter and sub millimeter wavelengths, Hard X-Ray (HXR) and Gamma-Ray (GR), H-alpha, and white-light. HXR/GR spectral analysis allows estimating the electron double power-law energy distribution at the origin of the non-thermal bremsstrahlung continuum emission. It is also shown that the high-energy (> ~0.8 MeV) part of this distribution is responsible for the > 20 GHz radio emission during the flare. By comparing flaring and quiescent active region solar atmosphere models, we find that most of the radiation excess at 30 THz observed during the flare is compatible with optically thin thermal free-free emission. The emitting source of assumed 10″ size, with temperature T ~ 8000 K is located at an altitude range of 960-1100 km above the photosphere where the mass column density varies from ~ 3.5 10-3 to 6.2 10-3 g cm-2. We finally show that the chromospheric heating, which results in the 30 THz excess radiation, can be due to energy deposited by non-thermal flare accelerated electrons,

protons and alpha particles in the quiescent atmosphere layer, which spans the same range of column densities.

Session 1 - Speaker

Peacock jets above the light bridge of a sunspot

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We are going to present the results of a study about a series of long scale and fan-shaped jets observed above the light bridge (LB) of the sunspot AR11785. These jets appear originating from bright footpoints located on one edge of the LB and moving along the LB. The goal of our research is to determine the origin, the dynamics and the thermal properties of the jets using H-alpha observations with the CRisp Imaging SpectroPolarimeter at the Swedish 1-m Solar Telescope and images from the Atmospheric Imaging Assembly (AIA) at the Solar Dynamics Observatory. The geometrical analysis performed on the CRisp data allows for a description of the dynamics; in particular these jets are characterized by a typical length of about 30 Mm and an inclination of about 30°-50° with the solar surface. The jets are impulsively accelerated to a speed of about 100 km/s close to photospheric footpoints in the LB and exhibit a constant deceleration of the order of the solar gravity projected on the jet axis. The images from the AIA reveal bright jet fronts in the hotter channels, especially in the wavelengths 13.1 nm, 17.1 nm and 30.4 nm. This suggests that the jets undergo a compressive heating as they reach the corona. The AIA optically thin channels allows also for the calculation of the differential emission measure (DEM) of the footpoints. From this analysis we obtain a value of the DEM in the footpoints that is two orders of magnitude larger than in typical active regions and comparable to transition region's temperature. The mechanism producing these jets is not totally clear but a likely explanation, supported by the presence of an opposite polarity of the magnetic field of the LB compared to the umbra, is a magnetic field reconnection taking place on the edge of the LB.

Session 1 - Speaker

Study of photospheric and chromospheric dynamics using high resolution spectropolarimetric observations

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We present the results obtained from the recent observing campaigns performed at the Dunn Solar Telescope (NSO) dedicated to the study of the interplay between plasma and magnetic field in the lower layers of the solar atmosphere. Using high resolution spectro-polarimetric datasets taken by the Interferometric BIdimensional Spectropolarimeter (IBIS) we found some new details about the sunspot dynamics and the magnetic properties of their features. The inversion of the Stokes profiles of the Fe I 617.3 nm line and of the Fe I 630.25 nm line allowed us to provide new constraints for improving the modelling of the processes leading to the evolution of sunspots (Romano et al. 2013, ApJL 771 3; Romano et al. 2014, ApJ 784 10). Moreover, we deduced some interesting results from the comparison of the photospheric lines with the chromospheric spectral data taken along the Ca II 854.2 nm line and the Halpha 656.3 nm line: many properties of the plasma flow in photosphere seem to be influenced by the overlying configuration of the magnetic field in the chromosphere. The coordinated observations with space-based instruments (IRIS, SDO) were useful to describe the global evolution of the targets, with a wider observation time interval and a complementary vision of the magnetic systems visible in the corona.

This research work has received funding from the European Commissions Seventh Framework Programme under the grant agreements no. 312495 (SOLARNET project) and no. 606862 (F-Chroma project). This research is also supported by the ITA MIUR-PRIN grant on "The active sun and its effects on space and Earth climate".

Session 4 - Speaker

The Solar Physics Research Integrated Network Group - SPRING

M. Roth, Kiepenheuer Institute for Solar Physics, Freiburg, Germany

SPRING is a project to develop a geographically distributed network of instrumentation to obtain synoptic solar observations. Building on the demonstrated success of networks to provide nearly-continuous long-term data for helioseismology, SPRING will provide data for a wide range of solar research areas. Scientific objectives include internal solar dynamics and structure; wave transport in the solar atmosphere; the evolution of the magnetic field over the activity cycle; irradiance fluctuations; and space weather origins. Anticipated data products include simultaneous full-disk multi-wavelength Doppler and vector magnetic field images; filtergrams in H-Alpha, CaK, and white light; and PSPT-type irradiance support. The data will be obtained with a duty cycle of around 90% and at a cadence no slower than one minute. The current concept is a multi-instrument platform installed in at least six locations, and which will also provide context information for large-aperture solar telescopes such as EST and the DKIST. There is wide support for the idea within the EU and the US solar research communities. The project is in the early planning stages, and we are open to and looking for participants in the science and instrument definition.

Session 5 - Invited Speaker

The GREGOR Solar Telescope

W. Schmidt, Kiepenheuer Institute for Solar Physics, Freiburg, Germany

Europe's largest solar telescope, GREGOR, has been used for scientific observations since 2014. In 2015, the international community started observations with this powerful instrument within the Solarnet Program.
GREGOR is one of the two modern solar telescopes of the 1.5 meter class that mark the new era of large-aperture open designs. This transition from the classical evacuated solar telescopes to the open ones is of great importance for the development of technologies that are needed to master the technical challenges of the next generation of 4-meter telescopes. GREGOR owes its name to the Gregorian optical design.
High-resolution observations with GREGOR are enabled by its powerful high-order adaptive optics. GREGOR is also a test bed for a multi-conjugated adaptive optics system that was developed at the KIS. The focal-plane instrumentation of GREGOR includes the Broad-Band Imager, with two imaging channels, the Gregor Fabry Perot Interferometer, a 2D spectro-polarimeter for visible wavelengths and the very near IR, and the GRegor Infrared Spectrograph, a scanning slit spectrograph for spectropolarimetry between 1.0 and 2.2 microns. Other instruments, like ZIMPOL, for extremely sensitive polarimetry are being adapted to GREGOR and will become operational soon.
The hitherto obtained scientific data demonstrate the capability of GREGOR for diffraction-limited imaging and for high-quality spectro-polarimetry. Examples will be presented during the talk.

Session 2 - Speaker

Magnetic field and plasma diagnostics from coordinated prominence observations

B. Schmieder (Observatoire de Paris, France), N. Labrosse (University of Glasgow), P. Levens (University of Glasgow), A. Lopez Ariste (IRAP, France), S. Gunar (University of St. Andrews)

We study from a statistical point of view the magnetic field in prominences by using THEMIS in the MTR mode performing spectro-polarimetry of the He D3 line.
Combining these measurements with spectroscopic data from IRIS, SOHO/EIS and ground-based telescopes (Meudon Solar Tower, Fuxian Solar Observatory, Ondrejov, Bialkow we determine the inferred temperature, density, and flow velocities of the plasma.
Multiple questions are open:
- What is the general orientation of the magnetic field in prominences? Is the model using a single orientation of magnetic field always valid for atypical prominences?
- Does this depend on the location of the filament on the disk (visible in Halpha, in He II 304) over an inversion line between weak or strong network?
- The study of the differential emission measure using Hinode/EIS data informs us about the plasma parameters of the prominences: are prominences in a weak environment field dominated by gas pressure?
- Measuring the Dopplershifts in Mg II lines (with IRIS) and in Halpha can tell us if there are substantial velocities to maintain vertical rotating structures, as it is suggested with tornado-like prominences.
We shall give some results obtained with different ground-based and space instruments in this framework.

Session 1 - Speaker

Is it possible to use the green coronal line instead of X rays to cancel an

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Total masses of six quiescent prominences observed from April through June 2011 were estimated using multi-spectral observations (in EUV, X-rays, H alpha,and CaII H) and method based on work of Heinzel et al. (2008). The method uses the fact that intensity of the EUV solar corona at wavelengths below 912 Å is reduced at a prominence by the absorption in resonance continua (photoionisation) of hydrogen and possibly by helium and subsequently an amount of absorbed radiation is proportional to the column density of hydrogen and helium plasma. Moreover, the deficit of the coronal emissivity in volume occupied by the cool prominence plasma also contributes to the intensity decrease. The observations in X-rays which are not absorbed by theprominence plasma, allow us to separate these two mechanisms from each other. The X-ray observations of XRT onboard the Hinode satellite made with the Al-mesh focal filter were used because the X-ray coronal radiation formed in plasma of temperatures of the order of 106 K was registered and EUV spectral lines occurring in the 193, 211 and 335 Å channels of the Atmospheric Imaging Assembly of the Solar Dynamics Observatory satellite are also formed at such temperatures. Unfortunately, the Al-mesh filter has a secondary peak of the transmittance at around 171 Å what causes a contribution from the EUV corona to the measured data of up to 10 % in the quiet corona. Thus, absorption in prominence plasma

influences XRT X-ray data when using the Al-mesh filter. On the other hand, other X-ray XRT filters are more sensitive to plasma of much higher temperatures (log T of the order of 7), thus observations using these filters cannot be used together with the AIA observations in the method for mass estimations. This problem could be solved using observations in the green coronal line instead of X-rays. Absorption of the green coronal line by a prominence plasma is negligible and this line is formed at temperatures of the order of 106 K. We compare values of the total mass of the prominence observed on 20 October 2012 on SE limb estimated when using XRT X-ray observations and observations in the green coronal line obtained at Kislovodsk Mountain Astronomical Station of the Pulkovo observatory (Russia).

Session 3 - Poster

Non-LTE inversion of spectropolarimetric and spectroscopic observations of a filament on 11 September 2014 at the VTT

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A filament in the active region NOAA 12159 (at solar disk coordinates [x,y] = [225,-440] arcsec) was observed with the Vacuum Tower Telescope at Tenerife on 11 September 2014. Full-Stokes spectropolarimetric observations in the HeI IR triplet at a wavelength around 10830 Å and the SiI 10827 Å line were performed using the Echelle spectrograph together with the Tenerife Infrared Polarimeter (TIP). Additional spectroscopic observations in the CaII 8542 Å line were obtained with the spectrograph. With the TESOS Fabry-Perot interferometer, the filament was observed in H_alpha in intensity mode with a field-of-view of 25 x 25 arcsec (136 wavelength points within the range 6561 - 6564 Å). Magnetic structure and properties of the photospheric plasma in the vicinity of the filament were inferred from the SiI 10827 Å line using the Stokes Inversion using Response function code (SIR; Ruiz Cobo & del Toro Iniesta 1992, Bellot Rubio 2003). From the HeI Stokes profiles a horizontal magnetic field of around 160 G was inferred in the filament using the Hanle Zeeman Light inversion code (HAZEL; Asensio Ramos, Trujillo Bueno and Landi Degl'Innocenti 2008).
The filament showed no activity in the CaII 8542 Å absorption profiles (no central emission, no high velocities). Therefore it was possible to use the 2D non-LTE model of a quiescent filament to simulate the H_alpha profiles obtained from TESOS to diagnose the filament hydrogen plasma. In this non-LTE model, the same magneto-hydrostatic structure of Kippenhahn-Schlueter type was used as in the non-LTE 2D prominence model of Heinzel and Anzer (2001).

Session 2 - Poster

Modified cloud method validation for determining physical parameters of a moderate flare on June 26, 1999

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The flare of 26 June 1999 was observed in the Hα line using the multichannel flare spectrograph (MFS) at the Astronomical Institute in Ondřejov, Czech Republic. We use a new technique different from the classical cloud model to fit the Hα line profiles which avoids using the background profile (Liu and Ding 2001). We obtain the four parameters of the flare chromosphere: the source function, the optical thickness at line center, the line-of-sight velocity and the Doppler width. The observed asymmetry profiles have been

reproduced well by the theoretical ones based on our model. A discussion is made about the reliability of the results we have obtained using the present method and the new results are reasonable for a better understanding of the flare dynamics.

Session 2 - Poster

Analysis of apparent ultra-fast spicules using high resolution ground-based data

J. Shetye (Armagh Observatory), J. G. Doyle (Armagh Observatory), E. Scullion (Trinity College Dublin), C. Nelson (University of Sheffield)

A statistical study of spectral images, taken from the CRISP instrument at the Swedish 1-m Solar Telescope in H-alpha 656.28 nm of fast spicules, present Doppler velocities in the range of -41km/s to +41 km/s. Remarkably, many of these spicules display apparent velocities above 500 km/s, with very short lifetimes of up to 20 s and apparent lengths of around 3500 km. Here we present, the other spectral properties of these events in the line scan. One result is that they are repetitive i.e. appear at the same location but they are not co-temporal or necessarily periodic in nature. In 89 % of the cases there is temporal offset by 3.7 s to 5 s. We interpret the observations as mass motions that appear in the field-of-view of CRISP's 0.0060 nm filters in the line of sight, along their projection. We observed that 30% of the features showed repetitions at same location. This confirms that these are in fact, elongated mass motions rather than so called sheets, fast spicules or fibrils. Further we observed lateral motion which could be related to waves. With DKIST VTF instrument, having 3 times more spatial resolution than CRISP and much higher temporal resolution, we can being to understand the nature of such fine-scale transient phenomena in greater details.

Session 3 - Speaker

Survey of 4 years of SDO/EVE observations of flare emission of H and He lines

P. J. A. Simões, L. Fletcher, N. Labrosse, G.S. Kerr (SUPA School of Physics and Astronomy, University of Glasgow)

Solar flares have dramatic coronal manifestations but the bulk of the flare radiation comes from the denser lower atmosphere, being the main location of flare energy dissipation and radiation. The presence and many of the characteristics of a particular spectral line or continuum are determined mostly by the physical properties of the environment in which it is formed. Further insight into the flaring chromospheric plasma can be explored by employing models. Realistic simulations of observable parameters, such as spectral line profiles and continuum emission, dictate that non-equilibrium plasma modeling must be treated together with non-LTE radiation hydrodynamics. Comparing the output of such models and observational data we may be able to piece together the characteristic structure of a flaring atmosphere. The Extreme ultraviolet Variability Explorer (EVE), on board of the Solar Dynamics Observatory (SDO) launched in 2010, provides Sun-as-star spectral measurements in the EUV range 5-105 nm, with spectral resolution of 0.1 nm. We present our survey of the 4 years of EVE observations of solar flares and the results of our analysis of the irradiance of H Lyman beta, gamma and delta, He I 58.4 nm, and He II 30.4 nm emission lines. The flare emission of these lines is usually strong enough to be detected by EVE, even for weak GOES C-class events. The observed irradiances are compared to the output of non-LTE radiation hydrodynamics models to better constrain the model input and help to provide a better diagnostic of the plasma temperature, density and ionization of the different ions in the flaring chromosphere.

Session 1 - Speaker

Slipping reconnection in a solar flare observed with GREGOR

M. Sobotka (1), J. Dudík (1), C. Denker (2), H. Balthasar (2), J. Jurčák (1), W. Liu (1), and the GREGOR Team;

A small flare ribbon above a sunspot umbra in active region 12205 was observed on November 7, 2014, at 12:00 UT in the blue imaging channel of the 1.5-m GREGOR telescope, using a 1 A Ca II H interference filter. Context observations from SDO/AIA, Hinode/SOT, and IRIS show that the ribbon is a part of a larger one that extends through the neighboring positive polarities and also participates in several other flares within the active region. A 140 second long time series of Ca II H images was reconstructed by means of the Multi-Frame Blind Deconvolution method, giving the respective spatial and temporal resolutions of 0.1 arcsec and 1 s. Light curves and horizontal velocities of small-scale bright knots in the observed flare ribbon were measured. Some knots are stationary but three move along the ribbon with speeds of 7 - 11 km/s. Two of them move in the opposite direction and exhibit highly correlated intensity changes, providing evidence for the presence of slipping reconnection.

Session 2 - Poster

Observational and physical parameters of type I chains and their association with flares in X-ray

Z. A. Luz Sodré and F. C. R. Fernandes, Universidade do Vale do Paraíba - UNIVAP, São José dos Campos, Brazil

Noise storms, also called of type I noise storms, are solar emissions in metric waves that originate in regions of high concentration of the magnetic field, such as active regions, and often are related to distinct changes in the solar corona and the release of energy, adjacent of the active region. The active regions are classified according to the complexity of the spots that make it up. Solar emission type I in metric waves is associated with active regions, but not directly to flares. Using data of the NOAA it was found that on days with the presence of flares have a larger number of storms and also more lasting. However, for days without the presence of type I flares occurred storms. Associated with storms are the chains of type I, whose spectral characteristics can be observed with high spectral and temporal resolution instruments such as the spectrographs of network e-CALLISTO. This work investigates the observational and physical parameters the chains of type I associated with the storms of the day 09/08/2011 (with the presence of flares) and the day 07/05/2011 (without the presence of flares). The results are presented and discussed.

Session 4 - Invited Speaker

Variations of the solar irradiance

S. Solanki, Max Planck Institute for Solar System Research, Göttingen, Germany

Variations in solar irradiance have been invoked as drivers of the Earth's atmosphere and its climate. Although, such variations and fluctuations have been followed for decades, partly even centuries, a number of important and basic questions surrounding them remain unanswered, or controversial. This also leads to significant uncertainties in the role played by the Sun in, e.g., driving climate change. In this lecture I provide an overview of our present knowledge and understanding of solar variability, covering both, observational and theoretical aspects.

Session 5 - Invited Speaker

Science Objectives and Instrument Designs of the SOLAR-C Mission

Y. Suematsu, National Astronomical Observatory of Japan, Tokyo, Japan

Solar-C is a mission designed to investigate the magnetic activities of the Sun, focusing on the heating and dynamical phenomena of the chromosphere and corona, and to

develop an algorithm for predicting short and long term solar evolution. For this purpose, three dedicated instruments aboard Solar-C; the Solar UV-Vis-IR Telescope (SUVIT), the EUV Spectroscopic Telescope (EUVST) and the High Resolution Coronal Imager (HCI), jointly observe the entire visible solar atmosphere with essentially the same high spatial resolution (0.1 - 0.3 arcsec), performing high resolution spectroscopic measurements over all atmospheric regions and spectro-polarimetric measurements from the photosphere through the upper chromosphere. In addition, Solar-C will contribute to our understanding on the influence of the Sun-Earth environments with synergetic wide-field observations from ground-based and other space missions. Some leading science objectives and the mission concept, including designs of the three instruments are presented.

Session 3 - Speaker

Implementation of partial frequency redistribution effects for chromospheric resonance spectral lines in 3D model atmospheres

A. Sukhorukov & J. Leenaarts; Institute for Solar Physics, Stockholm University

We implemented effects of non-coherent frequency scattering known as partial redistribution (PRD) in our radiative transfer code Multi3D to treat properly the formation of resonance spectral lines like Mg II k&h, Ca II K&H, H I Lymanα etc. Profile intensities of these lines are formed under PRD mostly in the chromosphere. They are widely accepted diagnostic tools for studying the upper solar atmosphere, where effects of photon scattering become important. We employed the hybrid approximation for the angle-dependent case of the Rrm II redistribution function as suggested by Leenaarts et al. (2012) to save both computational time and memory usage. We also performed an additional effective management of memory and time by properly choosing frequency quadrature points and by optimizing an algorithm for the mean intensity and the absorption profile interpolation. We compared profiles computed by our code with the profiles produced by the RH code (Uitenbroek 2001, Pereira & Uitenbroek 2015) using a standard 1D model atmosphere FAL-C for which we found a perfect agreement. Here we also present our recent modeling using a 3D~Bifrost model atmosphere. We discuss possible consequences resulting from the interpretation of observed PRD lines based on a simplifying approximation of complete frequency redistribution (CRD) as has been customary in observational solar physics before.

Session 2 - Poster

Interference of magnetic storms in plasma bubbles in the ionosphere over a period of solar minimum

F. Tardelli-Coelho, J. R. Abalde, A. J. de Abreu, Universidade do Vale do Paraíba - UNIVAP, São José dos Campos, Brazil

Studies presented on the Relation Sun-Earth system are of great importance currently. Ionospheric storms in the F-region, caused by geomagnetic storms have meanings and adverse effects on the Earth. The recent advancement in technology techniques for monitoring space weather has allowed major contributions to this aspect. The main research of this study was to determine whether there was some geomagnetic storm that interfere with the generation, propagation and durability of plasma bubbles that occurred over a period of solar minimum in two cities in the Brazilian sector, São José dos Campos - SP (23.21°S, 45.86°W; dip latitude 17.6°S), designated SJC, low-latitude region and near to south crest ionospheric equatorial anomaly and Palmas - TO, called PAL (10.28°S, 48.33°W; dip latitude 6.7°S), near to the magnetic equator, located in the geographical South, tropical region and the hemisphere opposite to the magnetic equator. This study was conducted with data analysis of five years (2006-2010) of SJC and four years (2007-2010) of PAL, considering the 24th solar cycle, using all-sky imaging photometer operating with interference filters in OI 630.0 nm emission resulting from dissociative recombination process $O_2^+ + e \rightarrow O + O^*$ (1 D) that occurs at an altitude of ~250-300 km (F-region).

Session 3 - Speaker

Exceptions to the rule: the X-flares of AR 2192 lacking coronal mass ejections

J. Thalmann, Y. Su, **M. Temmer**, A. M. Veronig (Institute of Physics, University of Graz, Austria)

The unusually large NOAA active region (AR) 2192, observed in October and November 2014, was outstanding in its productivity of major flares (GOES class M5 and larger). However, none of the X-flares was associated to a coronal mass ejection. The AR showed a predominantly north-south oriented magnetic system of arcade fields, which served as a strong, also lateral, confinement for the flares at the core of the active region. The large initial separation of the flare ribbons, together with an almost absent growth in ribbon separation suggests a confined reconnection site high up in the corona. Based on a detailed analysis of the confined X1.6 flare of Oct 22, we show how exceptional the flaring of this AR was. We find evidence for repeated energy release, presumably due to magnetic reconnection in a narrow flaring volume, closely associated to the location of hard X-ray sources. We demonstrate that a considerable portion of the magnetic energy released during the X-flare was consumed by the non-thermal flare energy.

Session 4 - Speaker

Tilt angles of solar filaments over the century: 1919-2014

A. Tlatov, K. Kuzanyan, V. Vasilyeva, Kislovodsk Mountain Astronomical Station, Main Astronomical Observatory of Russian Academy of Sciences

We study the distribution of solar filaments using the data from Meudon Observatory 1919-2003 together with Kislovodsk Mountain Astronomical Station 1979-2014. We scanned and digitized the observed H-alpha synoptic maps line, on which we isolated and digitized filament locations. We also carried out the digitization of filaments form daily observations of solar activity in 1965-2014. Data on each filament contain information of the location, length, area, position and other geometric characteristics. We obtained the distributions of the number and the length of filaments with time as well as their latitudinal drift with solar cycle. We also analyzed of the longitudinal distribution, the asymmetry over the northern and southern hemispheres and other characteristics.
We analyzed the tilt angles to the equator. On average, the Eastern ends of the filaments are closer to the poles than Western ones by some 10 degrees in latitude, that we prescribed positive tilts. To the contrary, in the sub-polar regions with latitudes greater than 50 degrees the filament tilt angles are mainly negative. The portion of filaments in the middle-latitude is not large (less than 30%).The tilt angles vary with the phase of solar cycle attaining theory maximum at maximum sunspot activity phase. The highest values for low-latitudinal filaments (below 40 degrees from the equator) have been attained in the middle of 20th century in solar cycles 18-19 at the time of maximum activity. We therefore propose using statistical properties of solar filaments as an additional coherent measure for manifestation of the solar cycle which covers all latitudes and has a systematic calibrated almost a century long available data series.

Session 4 - Poster

Numerical processing of sunspot images using the digitised long-term archives

A. Tlatov, N. N. Skorbez, Kislovodsk Mountain Astronomical Station, Main Astronomical Observatory of Russian Academy of Sciences

We present the results of applying our numerical algorithms for identification and parametrisation of sunspots from a long series of photographic observations made in white light during the period of time from 1918 to 1972 by the Royal Greenwich Observatory (RGO) and Kislovodsk astronomical station from 1954 to 2014. The main purpose of this work was creating a catalogue of individual sunspot parameters, which is a step forward with respect to the previous catalogues of this kind. The RGO archive

contains about 26000 photographic plates, and Kislovodsk more 18500 plates. All plates digitised with the resolution that corresponds to the Sun's image radius having approximately 1600 16-bit pixels. We have developed special numerical algorithms and implemented them in our image analysis software. The first stage of processing each photographic plate consists of identifying the solar disc image and projecting onto this image the heliographic coordinate grid corresponding to the date and time of observation. Then, we calculate the local Quiet Sun Level (QSL) brightness, which is used for determining the local contrast threshold for sunspot identification and localisation. Our software includes also manual screening of the automatically localised sunspots, which was used at the last stage of the solar image processing to filter or remove unavoidable photographic plate artefacts. In total, we have localized about 240 thousand ind ividual sunspots in RGO archive and about 200 thousand sunspots in Kislovodsk data. The calculated areas of these spots were compared with the results of manual measurements of these areas (www.ngdc.edu) and showed high correlation (R~0.98). We performed the analysis of the distributions of the leading and trailing sunspots. In the distribution of the leading sunspots have a maximum area of S ~ 120-150 mhm. In the distribution trailing sunspots such maximum is absent.

Session 3 - Invited Speaker

Numerical simulations of dynamic phenomena in the solar corona

T. Török, Predictive Science Inc., San Diego, CA, USA

The numerical modeling of the solar corona and of its dynamical phenomena has experienced significant progress in recent years. Present magnetohydrodynamic (MHD) simulations can be run on large spherical grids, include a realistic description of the energy transfer (thermodynamics) in the corona, and are capable of incorporating photospheric measurements as boundary condition for the magnetic field. These capabilities allow us to model the large-scale magnetic field and plasma distribution of the corona, the structure and dynamics of active regions, streamers, and coronal holes, as well as transient eruptive phenomena such as jets and coronal mass ejections (CMEs) in an increasingly realistic manner. In this talk, I will present some of these simulations and briefly discuss the next steps that lie ahead.

Session 1 - Invited Speaker

Quiet Sun and its dynamics as viewed from the ground and from space

K. Tziotziou, IAA, Space Applications and Remote Sensing, NOA, Penteli, Greece

Over the past years, state-of-the-art ground-based and/or space-based observations (filtergram, spectroscopic and spectropolarimetric), at a wide range of wavelengths, reveal that the quiet-Sun, just like active regions, is a highly inhomogeneous and dynamic environment that plays an important role in the global dynamics of the entire solar atmosphere. This dynamic quiet-Sun is manifested through a number of different types of features and phenomena that occur in a large range of spatial and temporal scales and are nowadays believed to be mostly driven by the local magnetic field and its dynamics. Ground-based observations processed with state-of-the-art, post-processing reconstruction techniques, often combined with simultaneous space-based observations from a variety of instruments on different spacecraft, offer a unique opportunity to investigate and understand the physical conditions of the local plasma, the nature, formation mechanisms and evolution of quiet-Sun phenomena and possible interrelationships between quiet-Sun phenomena occurring at different heights of the quiet-Sun solar atmosphere, from the photosphere and chromosphere to the transition region and low corona. We provide a comprehensive review of our latest understanding of quiet-Sun and its dynamics as viewed from the ground and from space and discuss the advantages/disadvantages of ground- and space-based observations and future advents in solar observations with new solar instruments.

Session 4 - Invited Speaker

Long term solar activity

I. Usoskin, Sodankylä Geophysical Observatory, University of Oulu, Finland

A review of the solar variability on long-term scale (from a decade to several millennia) is presented. The last 400 years are covered by direct solar observations in the form of sunspot counts but is it representative for the overall solar variability? For longer time scale, up to ten millennia, we use indirect proxies, such as cosmogenic radionuclides (14C and 10Be) stored in stratified natural archives. Uncertainties of the solar activity reconstructions are discussed. Special attention is paid upon the occurrence of Grand minima and maxima of solar activity.

Session 4 - Poster

The Maunder minimum: A reassessment from multiple datasets

I. Usoskin, Sodankylä Geophysical Observatory, University of Oulu, Finland

It is a current paradigm that the Maunder minimum (MM) in 1645-1715 was a period of greatly suppressed, but not completely vanished, solar activity. However, because of uncertainties related mostly to ambiguity of some historical sunspot observation records, the exact level of solar activity during the MM is somewhat unclear, leaving room for continuous discussions and speculations. Here we provide a full reassessment of the Maunder minimum using all the available datasets: augmented sunspot counts and drawings; revisited historical archives; both well-known and newly revealed records of auroral observations; cosmic ray variability via cosmogenic isotope. We show that, while the exact level of the activity is not easy to determine, the Sun indeed exhibited exceptionally low magnetic activity during the MM with very low solar surface magnetic activity, low intensity of the interplanetary magnetic field, as well as lower frequency and higher geographical latitude of auroral occurrence.

Session 1 - Poster

Millimeter Observations of the 2013 February 17 Solar Flare

A. Valio, D. F. Silva (CRAAM - Mackenzie University, São Paulo, Brasil)

Due to the great complexity of a solar flare, the study of many wavelengths is necessary to understand the physical processes involved. By fitting the radio spectra of solar flares with theoretical models, the evolution of some physical parameters of the flaring source is obtained, such as the magnetic field, electron density, spectral index. The objective of this work is the analysis of the radio spectrum at high frequencies, especially the evolution and energy distribution of the population of accelerated electrons. Here, we present the investigation of the solar flare of February 17, 2013 that occurred at 15:47:10 UT. This event was studied in radio from 5 to 405 GHz, and also in X-rays from RHESSI. The spectrum was fitted by a power law, which provided the peak frequency and spectral indices of optically thin and optically thick regimes. The results yield a spectral hardening in the range of 45 to 405 GHz, and that both the temporal profile and the spectral index are different for the millimeter and microwave emission.

Session 1 - Speaker

High-resolution 3D flow fields around solar active regions

M. Verma (1), C. Denker (1), S.J. González Manrique (1,2), M. Sobotka (3) and the GREGOR Team; 1 - Leibniz-Institut für Astrophysik Potsdam (AIP), Potsdam, Germany, 2 - University of Potsdam, Germany, 3 - Astronomical Institute, Academy of Sciences of the Czech Republic, Czech Republic

Accurate measurements of magnetic and velocity fields in and around solar active regions are key to unlocking the mysteries of the formation and the decay of sunspots. High spatial resolution image and spectral sequences with a high cadence obtained with the GREGOR solar telescope give us an opportunity to scrutinize 3-D flow fields with local

correlation tracking (LCT) and imaging spectroscopy. We present GREGOR early science data acquired in July/August 2014 with the GREGOR Fabry-Pérot Interferometer (GFPI) and the Blue Imaging Channel (BIC). Time-series of blue continuum images (λ 450.6 nm) images of the emerging flux region NOAA 12118 were restored with the speckle masking technique to derive horizontal proper motions and to track the evolution of morphological changes. Growth and decay rates for area and magnetic flux are presented. In addition, we searched the GREGOR/GFPI data archive for occasions when new flux emerges or old flux decays and present the respective Doppler maps. All high resolution observations are discussed in the context of synoptic data from the Solar Dynamics Observatory (SDO).
The 1.5-meter GREGOR solar telescope was built by a German consortium under the leadership of the Kiepenheuer Institute for Solar Physics in Freiburg with the Leibniz Institute for Astrophysics Potsdam, the Institute for Astrophysics Göttingen, and the Max Planck Institute for Solar System Research in Göttingen as partners, and with contributions by the Instituto de Astrofísica de Canarias, the Istituto Ricerche Solari Locarno, and the Astronomical Institute of the Academy of Sciences of the Czech Republic.

Session 4 - Invited Speaker

Space Weather using ground based data

A. Veronig, Kanzelhöhe Observatory/Institute of Physics, University of Graz, Austria

In this talk, I review the availability and use of ground-based observations for the study of the solar sources of space weather. High-cadence full-disk imaging in the H-alpha spectral line provides us with a valuable means to identify solar flares, erupting filaments which may be associated with Earth-directed coronal mass ejections, and Moreton waves indicating shock waves propagating through the solar corona. We present the automatic real-time detection of solar flares and filaments, which was developed and implemented at the Kanzelhöhe Observatory H-alpha observing system (in the frame work of ESA's SSA space weather segment, http:// http://swe.ssa.esa.int). Specific problems related to ground-based observations and the potential of observing networks for space weather research will be discussed.

Session 3 - Speaker

Solar Magnetoconvection simulated with the MANCHA code

N. Vitas, E. Khomenko, Instituto de Astrofisica de Canarias, La Laguna, Tenerife, Spain

Realistic radiative MHD simulations are important tool for understanding the structure and dynamics of the solar photosphere and the near-surface convection. There is a number of numerical codes designed specifically for that type of simulations (MURaM, STAGGER, Co5Bold, Bifrost and others). Here we present the first convection simulations performed with the MANCHA code developed by the SPIA team of the IAC (Khomenko et al.). The code solves the quasi-MHD equations (including ambipolar diffusion) together with the non-grey radiative transfer equation and the realistic equation of state. We describe the details of the MANCHA code and show examples of it application to different problems of the solar atmosphere.

Session 3 - Poster

Forecasting the arrival of Coronal Mass Ejections: The Drag-Based Model

B. Vršnak, T. Zič, J. Čalogovič, M. Dumbovič, Hvar Observatory, Faculty of Geodesy, University of Zagreb, Zagreb, Croatia

We present a new space weather online forecast-tool for predicting the arrival of Interplanetary Coronal Mass Ejections (ICMEs). The forecast-tool is based on the "Drag-Based Model" (DBM), developed in the frame of the European Commission FP7 Project SOTERIA (SOlar-TERrestrial Investigations and Archives) and advanced within FP7 Project COMESEP (Coronal Mass Ejections and Solar Energetic Particles) and the Croatian

Scientific Foundation Project SOLSTEL (Solar and Stellar Variability). The DBM is based on a hypothesis that the driving Lorentz force that launches CME ceases in the upper corona, and that beyond certain distance the dynamics becomes governed solely by the interaction of the ICME and the ambient solar wind. This assumption is founded on the fact that in the interplanetary space fast ICMEs decelerate, whereas slow ones accelerate, showing a tendency to adjust their velocity with the ambient solar wind. In particular, we consider the option where the drag acceleration has the quadratic dependence on the ICME relative speed, which is expected in the collisionless environment, where the drag is caused primarily by emission of MHD waves. This is the simplest version of DBM, where the equation of motion can be solved analytically, providing explicit solutions for the Sun-Earth ICME transit time and the impact speed. DBM offers easy handling and straightforward application in the real-time space-weather forecasting. DBM results are compared with remotely-measured interplanetary kinematics of several ICMEs, whereas forecasting abilities are validated on the statistical basis by employing in situ measurements. Finally, the advantages and drawbacks of DBM are summarized.
This work has been supported by Croatian Scientific Foundation under the project 6212 „Solar and Stellar Variability" (SOLSTEL).

Session 3 - Speaker

What Additional Measurements Are Needed for the Magnetohydrodynamic (MHD) Simulation of Solar Atmospheric Dynamics?

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It has been well recognized from observation that the active-region magnetic field evolution is closely related to solar eruptive features such as flares and coronal mass ejections (CMEs). Magnetohydrodynamic (MHD) simulation has become a necessary tool for interpretation and revelation of the new physics of these observations to enhance our understanding and knowledge in the area of solar eruptive features. Therefore, assurance of a realistic MHD simulation is a necessary first step, specifically; the observed physical parameters must be used as constraints for the MHD simulation. Theoretically, MHD simulation is an initial boundary value problem as the solar atmospheric dynamic flows spread from the subsonic/Sub- Alfvénic to supersonic/super-Alfvénic flow region. Hence, specific rules prescribe the self-consistent boundary conditions which are needed, thus, the method of characteristics is the rule to assure the self-consistency. There are eight physical quantities for the MHD simulation which are the three components of the magnetic and velocity field plus thermodynamic properties (i.e. density and temperature). Presently, the routine measurements are made up from three components of the photospheric magnetic field, but according to the method of characteristic theory, we need to specify five specified quantities on the boundary for the MHD simulation to assure the self-consistency of the simulation. In this presentation, a brief description of the method of characteristics will be given. Then, two numerical examples will also be given to illustrate the importance of additional measurements. This will show that that the simulation results more closely resemble the observation if five quantities are specified on the boundary. We suggest two more measurements are needed for better and more reliable MHD simulation. These two quantities can be chosen from those five un-measured physical quantities which are either velocity field or thermodynamic properties.

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