This project is supported by the European Commission's FP7 Capacities Programme for the period April 2013 - March 2017 under the Grant Agreement number 312495.

www.solarnet-east.eu

DELIVERABLE D30.2

Progress and Final Reports Issued by Host Institutions Concerning Short Stays

WP30 Solar Physics Networking

1ST Reporting Period

November 2014

This project is supported by the European Commission's FP7 Capacities Programme for the period April 2013 - March 2017 under the Grant Agreement number 312495.

PROJECT GENERAL INFORMATION

Grant Agreement number: 312495

Project acronym: SOLARNET

Project title: High-Resolution Solar Physics Network

Funded under: FP7-INFRASTRUCTURES: INFRA-2012-1.1.26 - Research Infrastructures for High-Resolution Solar Physics

Funding scheme: Combination of Collaborative Project and Coordination and Support Action for Integrating Activities

From: 2013-04-01 to 2017-03-31

Date of latest version of Annex I against which the assessment will be made: **13/02/2013**

Periodic report: 1st **X** 2nd ☐ 3rd ☐ 4th ☐

Period covered: from **01/04/2013** to **30/09/2014**

Project's coordinator: Dr. Manuel Collados Vera, IAC.

Tel: (34) 922 60 52 00

Fax: (34) 922 60 52 10

E-mail: mcv@iac.es

Project website address: http://solarnet-east.eu/

This project is supported by the European Commission's FP7 Capacities Programme for the period April 2013 - March 2017 under the Grant Agreement number 312495.

DELIVERABLE 30.2

Progress and final reports issued by host institutions concerning short stays

According to the deliverable D30.2, the researcher in the host institution responsible for the short visit carried out in the framework of the "Mobility of young researchers" program of the SOLARNET project has to deliver a final report.

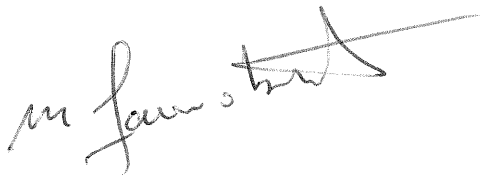
In the following pages we attach all the reports issued at this time.

Nice, June 23rd, 2014

Pr. Marianne Faurobert
marianne.faurobert@unice.fr

Short report on the collaboration stay of Ivan Milic at the Lagrange Laboratory on January-February 2014.

The research program that we carried out during this short collaboration visit was part of the PhD thesis that Ivan Milic will defend in September at the University of Belgrade.
It aims at investigating multi-dimentional radiative transfer effects on the scattering polarization of solar lines formed in the photosphere of the quiet Sun and in solar prominences.
Namely, during his Solarnet funded stay in Nice we worked on improving a 2D-polarized radiative transfer code written in cartesian coordinates that Ivan had developped previously. We implemented effects of velocity fields, inhomogeneities, and the Hanle effect of large scale magnetic fields. The code has been applied to simple models of solar prominences that have been presented at the workshop organized in Prague in May by the COST action on « Polarization as a tool for investigating solar system and beyong ».
During this stay we also started to work on new Themis observations of the center-to-limb variation of scattering polarization observed at the solar limb in various photospheric and chromospheric lines. The aim of this study was to obtain constraints on the depth-gradient of weak unresolved magnetic fields in the quiet Sun. However it turned out that some unexpected activity was taking place at the north limb during our observing run in July 2012. We are still working on the interpretation of the observed features.
We will acknowledge the SolarNet funding in the publications related to this work.



Marianne Faurobert

SOLARNET Mobility Program: Mobility of young researchers

Stay of Iker Sánchez Requerey at the Instituto de Astrofísica de Canarias.

B. Ruiz Cobo
Instituto de Astrofísica de Canarias,
38205, La Laguna, Tenerife, Spain; email: brc@iac.es

From January 31st 2014 until April 6th 2014 Iker Sánchez Requerey visited the Instituto de Astrofísica de Canarias (IAC) in order to collaborate with Basilio Ruiz Cobo in the analysis and inversion of disk center quiet-Sun spectropolarimetric observations obtained with three different instruments: CRISP (at the SSVT, Scharmer 2006 A&A 447, 1111), IMaX (at Sunrise Balloon, Martínez Pillet et al. 2011 Sol. Phys 2011, 269, 57) and the spectropolarimeter SP (at Hinode satellite, Tsuneta et al 2008 Sol Phys 249 167).

In a previous work Sánchez Requerey and collaborators (Requerey et al. 2014, ApJ 789, 6) taking advantage of the unprecedented high-quality IMaX observations reported on the formation and evolution of a small kG flux concentration and its interaction with the surrounding granulation. The data suggested that the magnetic element was formed by advective coalescence of small-scale flux patches and a subsequent convective collapse phase. Once formed, the evolution of the mature flux tube is much more complicated than that explained by static flux-tube models. Many different phenomena are involved, namely: converging granules and granular fragments, downflow jets, bright points (BPs), oscillations in all basic physical quantities, small-scale upflow plumes, etc.

Among the results found in this work, one of the most outstanding is the detection of small-scale upflow features emerging within the magnetic element and opposite to a strong downflow, in such a way that an upward/downward

38200 - La Laguna
Tenerife - España
Tel.: 922 60 52 00

Fax: 922 60 52 10
postmaster@ll.iac.es
http://www.iac.es

velocity pattern is observed within the flux tube. In order to deepen the study of this phenomenon it is needed to obtain the stratification through the atmosphere of physical quantities as temperature, magnetic field vector and line of sight (LOS) velocity. This can be done by the application of an inversion code like SIR (Ruiz Cobo & del Toro Iniesta 1992 ApJ 398, 375).

During his stay at the IAC, Sánchez Requerey made a great work, being able to master SIR code in the different configurations required to invert CRISP, IMAX and SP/Hinode data. The inversion of IMaX and CRISP data, in spite of their extreamly high spatial resolution, did not produce reliable stratifications of the magnetic field vector and LOS velocities. We could not go further than Milne-Eddington inversion, i.e., we only obtained the average with height of these quantities. The reason of this limitation seems to be the low spectral sampling of CRISP and IMaX data.

Due to the higher spectral resolution of the Hinode spectropolarimeter, we found that these data were more interesting for our purposes. Using these data, we have also observed upward/downward velocity patterns within many other quiet Sun magnetic structures. In particular, and due to the better spectral sampling of the data, these small-scale downflow (upflow) features exhibit two humps in the red (blue) lobe of the Stokes V profiles. Such a Stokes V profiles indicate the presence of an additional V signal with the same polarity but larger velocities along the LOS. We fitted the profiles produced by the downflows using two magnetic atmospheres with different LOS velocities as well as with SIRGAUSS (Bellot Rubio 2003, ASP Conf. Ser 307, 301). The latter is a modified version of SIR, which considers Gaussian perturbations along the LOS stratification for the atmospheric parameters. The three lobed Stokes V profiles produced by the upflows have weaker signal than the ones produced by the downflows, and consequently it is much harder to fit them.

We are presently working on the analysis of the resulting models.

La Laguna, 30 June, 2014

Catania, August 25, 2014

SOLARNET Mobility Program: Mobility of Young Researchers

Stay of Dr. David MacTaggart at INAF – Catania Astrophysical Observatory

From June 1st to July 31st 2014 Dr. David MacTaggart visited the INAF-Catania Astrophysical Observatory in the framework of the SOLARNET Mobility Program, to collaborate with Dr. Salvo Guglielmino and Prof. Francesca Zuccarello.

Aim of this collaboration was to apply numerical simulations of magnetic flux emergence in the solar atmosphere to some observations concerning the occurrence of surges during the emergence of ephemeral regions in the solar atmosphere. In previous works, MacTaggart and Haynes (2014, MNRAS, 438, 1500) studied MHD models of emerging ephemeral regions that produce multiple large-scale eruptions. By studying the magnetic connectivity, they showed that the evolution of the eruptions can differ and different magnetic topologies can support rising loops of dense plasma. These models predict that rising dense loops form due to a combination of effective overlying reconnection, shearing at the polarity inversion line, compression flows due to draining plasma and, in some cases, internal reconnection.

On the other hand, the Solar Physics Group in Catania had published in the past years some results concerning the presence of small scale surges during the emergence phase of ephemeral regions, deduced from the analysis of high resolution spectropolarimetric data acquired from ground based telescopes (IBIS@DST and CRISP@SST) (Guglielmino et al. 2010, ApJ, 724, 1083; Zuccarello et al. 2014, ApJ, 787, 57).

During his stay in Catania, Dr. MacTaggart developed 3D MHD flux emergence models to study how the reconnection and the geometry of the evolving field produce and guide the flowing of the surges, in order to verify whether the simulations can reproduce the observational characteristics of surges in emerging ephemeral regions. The ambient magnetic field in the models was chosen so that, at least initially, strong reconnection would not occur with the emerging field, in order to prevent the development of strong jets and large-scale eruptions. For each of the models, the magnetic topology was calculated in order to find the locations of reconnection. A paper entitled "The magnetic structure of surges in small-scale emerging flux regions", describing the research carried out by Dr. MacTaggart in Catania has been submitted to Astronomy & Astrophysics.

The main results shown in this paper are that surges follow the magnetic field geometry and manifest themselves as dense filamentary flows. These results matched well with observations, as did typical predicted velocities. The models produced four general stages of reconnection: 1. reconnection at the sides of the emerging region, 2. smooth reconnection at one point at the apex of the emerging region, 3. tearing instability at the apex of the emerging region, 4. internal reconnection within the emerging region.

Each stage is associated with a particular geometry for the field which determines the paths of surges. For example, in stage 2, when reconnection begins at the top of the emerging region, surges created in the corona flow along reconnected field lines down to the chromosphere, confirming the observations. Observations of these signatures could be used to determine whether or not an emerging region will produce large-scale eruptions.

We believe that the results obtained by Dr. MacTaggart during his stay in Catania are very interesting and we hope to continue to collaborate with him on this topic in the future.

Dr. Grazia Umana

Director of INAF-Catania
Astrophysical Observatory

Prof. Francesca Zuccarello

Supervisor

Kiepenheuer-Institut für Sonnenphysik
Stiftung des öffentlichen Rechts des Landes Baden-Württemberg
Mitglied der Leibniz-Gemeinschaft

Kiepenheuer-Institut für Sonnenphysik | Schöneckstrasse 6 | 79104 Freiburg | Deutschland

Dr. Andrés Asensio Ramos
SOLARNET
Mobility of Young Researchers
Instituto de Astrofísica de Canarias

La Laguna, Tenerife, España

Schöneckstraße 6
79104 Freiburg im Breisgau
Deutschland
Telefon: +49 761 3198-212
Fax: +49 761 3198-111
E-Mail: schliche@kis.uni-freiburg.de
Internet: www.kis.uni-freiburg.de

Rolf Schlichenmaier
Betreff: SOLARNET mobility Mariachiara Falco
Freiburg, den 18. Juli 2014

SOLARNET: Mobility of Young researchers: Mariachiara Falco at KIS

Dear Andrés,

Mariachiara Falco, a PhD student from INAF, working under the supervision of Prof. F. Zucharello at the Catania Astrophysical Observatory, worked with us at the Kiepenheuer-Institut für Sonnenphysik in Freiburg. She stayed from April 10, 2014 until July 11 2014.

During her stay she was supervised by Dr. Juan Borrero and myself. She became acquainted with applying the ‚SIR' inversion code on an excellent spectropolarimetric data set, which she previously acquired at the SST with CRISP. The usage of SIR is not straigth forward and requires sophisticated knowledge about the input parameters: Initial condition for the stratification (temperatures and pressure versus optical depth), physical parameters (magnetic and velocity field versus optical depth), the spectral psf, the number of components and nodes, etc. Mariachiara has performed numerous tests and became acquainted with the SIR inversion code. We are convinced that now, after her stay is finished, she has advanced her understanding of SIR such that she will be able to apply SIR successfully without assistence.

Best greetings,

Rolf Schlichenmaier

SOLARNET MOBILITY PROGRAM – HOST INSTITUTE REPORT

Mobility Researcher: Dr Eamon Scullion (University of Oslo, Norway)

Visiting Institute: Astrophysics Research Centre,
Queen's University Belfast (QUB), UK

Visiting Period: 15th October 2013 – 24th December 2013

QUB staff who worked with Dr Scullion: Prof M. Mathioudakis, Dr V. Henriques, Dr David Kuridze, Mrs Rebecca Hewitt, Mr Aaron Reid

Background:

Queen's University Belfast (QUB) constructed and operates the Rapid Oscillations in the Solar Atmosphere (ROSA) imager, available at Dunn Solar Telescope (DST) at the National Solar Observatory in New Mexico, USA. ROSA comprises of 6 imaging cameras that can observe the Sun with a temporal resolution as high as 0.03 seconds. ROSA co-observes routinely with the Interferometric Biodimensional Spectrometer (IBIS) which is also available at the DST.

Research carried out during the visit:

1. Incorporating ROSA/IBIS data within the CRISPEX

The visiting researcher, Eamon Scullion, has extensive experience with the implementation of software that performs accurate co-alignment of the Swedish Solar Telescope (SST) CRisp Imaging Spectro-Polarimeter (CRISP) data with other ground-based and space-borne instruments (i.e. AIA/SDO). During his visit he worked with ROSA (Ca II K, G-band, and 417nm continuum) and IBIS (Halpha and Ca II 854.2nm) image sequences of a 2 hour dataset obtained on AR 11372 on the 10th of December 2011. He implemented his software on the ROSA/IBIS dataset and was able to accurately co-align the images with each other and with co-temporal/co-spatial Atmospheric Imagine Assembly (AIA) observations from the Solar Dynamics Observatory(SDO). These datasets have now been made available through the CRISPEX

visualizations software. The data are currently been interpreted.

2. Stable Umbral Chromopsheric Structures

During the visit we also pursued a joint project on the analysis of the chromosphere in sunspot umbra. The dataset was analysed using the CRISPEX visualisation software. Filtergrams in the core of Ca II H and Halpha lines were used to create composite images that track the propagation of umbral frashes horizontally. A number of discrete structures are identified that are stable through multiple flashes. Using theoretical line formation heights we computed the inclination angles of these structures and find strong departures from the vertical. The structures are not ephemeral and their highly inclined nature suggests that a significant amount of the magnetic field in the sunspot umbra does not reach the transition region and corona. A related paper has been submitted for publication in Astronomy Astrophysics.

3. Analysis of SST data for the study of Ellerman Bombs (EBs)

During the visit emphasis was also place on a high quality SST dataset on EBs. The dataset was co-aligned with the CRISPEX routines. The observations included both on-disk and limb targets. The limb observations show that a jet that is seen in the blue wing of the Halpha, triggers the EB causing it to eject material and extends upwards. From the on-disk observations it appears that the EB is connected to a jet propagating away from the foot-point. The EB splits itself into microjets with velocities of about 10 km/sec. The on-disk observations are reproduced with models of radiative magnetoconvection. It is proposed that the magnetic reservoir of the intergranular lanes is used to fuel the EBs. A joint publication is currently been prepared.

The report has been prepared by Mihalis Mathioudakis

Professor in Physics and Astronomy

University
of
St Andrews

University of St Andrews

School of Mathematics & Statistics

3 June 2014

Dear Sir/Madam,

Mr Petros Syntelis

Mr Petros Syntelis visited the School of Mathematics and Statistics during the period 31st January until 15th May. During his stay here, he worked as a part of the Solar MHD Theory Group, having the benefits of office space, desk, computer equipment and access to the computer clusters to perform numerical simulations. In particular, he worked on numerical simulations of flux emergence in the Sun with Prof Alan Hood and Dr Vasilis Archontis.

Specific Details about his visit:
Name of Institute: School of Mathematics and Statisttics
Name of University: University of St Andrews
Period of visit: 31st January – 15th May
Topic of research: Numerical simulations of magnetic flux emergence in the Sun
Laboratory: Solar and Magnetospheric Theory Group
Language: English
Name of researcher: Petros Syntelis

If you require any further information regarding Mr Syntelis' visit please do not hesitate to contact me

Yours faithfully,

Prof Nik Ruskuc
Head of School

Mathematical Institute, North Haugh, St Andrews, Fife KY16 9SS, Scotland
Secretary: 01334 462344/463744 Direct Line: 01334 46
Fax: 01334 463748 Email: st-andrews.ac.uk

Università degli Studi di Roma "Tor Vergata"
Dipartimento di Fisica

PROT. 243
POS. C6

Progress Report of Ms Rebecca Hewitt

This document reports on the scientific work of Ms Rebecca Hewitt during her stay at the Department of Physics, University of Rome "Tor Vergata", between 29th of March until 31th of May, 2014. During her visit, Ms Rebecca Hewitt worked on the comparison of MHD numerical simulations of Bright Points (BPs encheforth) with spectropolarimetric observations, under the supervision of Dr. Dario Del Moro of the Solar Physics Group of the University.

The aim of this investigation was to compare the details of the formation and evolution of magnetic BPs on the solar photosphere as simulated by the MURAM code and as observed with the Interferometric BIdimensional Spectrometer (IBIS) instrument. In particular, the research included the comparison of the sinthetic and observational of Stokes profiles and of the physical quantities from the simulation and those retrieved by spectropolarimetric inversion.

The dataset used in this study is composed of 50 sequences, containing a 45 point scan of the FeI 630.1-630.2 nm region with a spectral sampling of 22.95 mA. Each image consists of a couple of polarimetric measures (I ± Stokes parameter). For each spectral image a WL and a G-Band counterpart, approximately imaging the same Quiet Sun FOV, have been acquired. The resolution of the spectral images is almost limited by pixel sampling (pixel scale=0.18" and resolution element ~0.4"), while the WL and the G-Band images, having smaller pixel-scales (0.09" and 0.04", respectively) and being restored via MFBD technique, have a resolution element ~0.2" and ~0.1", respectively.

Present models invoke the necessity for the 'convective collapse' process for the formation of the magnetic BPs. Among the goals of this study is the identification of the signatures of the convective collpase in the early stages of the BP evolution.

The MURAM code solves the radiative MHD equations over a 3D grid and simulates the upper convection zone and solar photosphere. This time sequence of physical parameters of the plasma in the solar atmosphere has been used to compute the G-band intensity and the full Stokes profiles for the FeI 630.25 nm line emerging from the photosphere, using the STOPRO radiative transport routine. To simulate how the convective collapse would manifest in spectropolarimetric observations, these images were degraded accordingly to the observational conditions, considering the spectral and spatial resolution degradation and the SNR levels, thus creating a sinthetic dataset with approximately the same characteristics as the acquired one. On both datasets, the same tracking algorithm has been applied, to obtain the positions in time of the BPs present in the FOV.

Ms Hewitt compared the evolution of several tracked BPs, visualizing both observational parameters (FeI 630.25 nm Stokes profiles, continuum and G-band intensity) and physical quantities (LoS velocity, magnetic field strenght, etc.) derived

directly from the observation (COG method) and via spectropolarimetric inversion (NICOLE code).

She concluded that some features of convective collapse are visible in both the degraded sinthetic dataset and the acquired one, but some diffrences in the magnetic field strenght and LoS velocities deserve a deeper investigation. In particular, she believes that part of these discrepancies may arise from the average magnetic field in the simulation being too high, with an average of 200G (typical of a plage-like structure). Introducing a weaker and bipolar field in the simulation box could create a more realistic Quiet Sun situation to be compared with the observations. She is at present time working on obtaining such simulations.

The results of this study will be soon submitted to a relevant journal (likely A&A) to be published. The possibility of applying for IBIS observation dedicated to extend and reinforce this study in under consideration.

Signed:

Prof. Rossana Marra

Head of Physics Department

Date:

Signed:

Dr. Dario Del Moro

Internal Supervisor

Date: 24/06/2014