Istituto Ricerche Solari Locarno

Rapporto 2016

Rapporto alla Fondazione Istituto Ricerche Solari Locarno sulla situazione dell'Istituto alla fine del 2016 e sul piano di lavoro per il 2017

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staff dell'IRSOL

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Indice

1 PREMESSA

Il 2016 è il primo anno che vede l'IRSOL quale istituto associato con l'Università della Svizzera Italiana. Sono stati mossi i primi passi per dar forma concreta a questa relazione. In particolare, abbiamo già sottoposto al Fondo Nazionale, nell'ambito del programma "Sinergia", un progetto specifico che richiede l'integrazione di competenze specifiche dell'IRSOL e dell'Istituto di Scienze Computazionali dell'USI. E' stato inoltre redatto un documento che fissa le linee guida dell'associazione.

La domanda di finanziamento per gli anni 2017 - 2020 inoltrata alla Segreteria di Stato per la formazione la ricerca e l'innovazione, SEFRI, ha ricevuto una risposta positiva. Questa decisione era cruciale per l'esistenza dell'istituto, in quanto ulteriori finanziamenti del Cantone, dei Comuni e pure la possibilità di richiedere fondi competitivi dipendevano dalla decisione del SEFRI.

Il Fondo Nazionale Svizzero per la ricerca scientifica ha accettato di finanziare un progetto che prevede la collaborazione con il Kiepenheuer Institut für Sonnenphysik di Freiburg (D) e lo statunitense National Solar Observatory. Il progetto prevede l'assunzione di un postdoc e di un dottorando.

Il comitato scientifico consultivo dell'IRSOL si è riunito per la prima volta a Locarno per analizzare la situazione dell'IRSOL. Il loro lavoro, riassunto in un rapporto, è risultato estremamente costruttivo e utile.

A fine anno il nostro dottorando Giovanni Privitera ha conseguito il titolo di dottore in scienze naturali all'Università di Ginevra grazie al suo lavoro diretto dal Prof. Georges Meynet dell'Osservatorio di Ginevra: *Star-planet interactions: Planetary orbital evolution and Engulfment.*

In ottobre abbiamo eseguito una campagna osservativa al telescopio GREGOR a Tenerife. I risultati scientifici sono consistenti e i risultati sono in corso di pubblicazione.

Il nuovo esperimento Chromospheric Layer SpectroPolarimeter (CLASP-2) é stato approvato dalla NASA. CLASP-2 é un esperimento di tipo "sounding rocket" (razzo sonda), in cui collaborano la agenzie spaziali statunitense (NASA) e giapponese (JAXA), e diversi istituti europei, tra cui l'IRSOL, attraverso l'attivitá di Luca Belluzzi. Il lancio é previsto nel 2019.

Il sito Web dell'IRSOL è stato ridisegnato e ammodernato.

Il tema di ricerca fondamentale dell'IRSOL è legato alla spettropolarimetria solare. La strumentazione che permette misure uniche, grazie al polarimetro ZIMPOL, viene migliorata costantemente. I dati osservativi vengono interpretati applicando, e sviluppando ulteriormente, le teorie piú sofisticate oggi disponibili, e attraverso l'ausilio di modelli numerici 3D dell'atmosfera solare, il cui sviluppo richiede l'utilizzo di supercalcolatori, quali quelli disponibili al centro di calcolo CSCS di Lugano. Il lavoro sinergico in queste attività permette di sviluppare nuove tecniche diagnostiche per misurare l'intensità e l'orientazione del campo magnetico nell'atmosfera solare.

Vi sono anche notizie meste: nel 2016 ci hanno lasciati il presidente onorario della FIRSOL e la persona che ha progettato e costruito il telescopio dell'IRSOL. I primi giorni del 2017 ci ha pure lasciati un membro del consiglio di fondazione.

RINGRAZIAMENTI

Nel 2016 hanno concluso il loro mandato nel consiglio di fondazione della FIRSOL persone che hanno avuto un ruolo centrale nello sviluppo dell'IRSOL negli ultimi anni. Tutto il personale dell'istituto è loro estremamente grato.

- **Prof. Dr. Piero Martinoli**

  Membro del Consiglio di fondazione FIRSOL come rappresentante del Canton Ticino dal 2013, presidente dell'Università della Svizzera Italiana, USI. Il suo contributo di analisi lucida della situazione ha permesso di precisare quali premesse doveva soddisfare l'istituto per sottomettere una richiesta di associazione all'USI. I suoi commenti e suggerimenti si sono sempre rivelati di grande utilità per pianificare lo sviluppo dell'istituto.

- **Dr. Sandro Rusconi**

  Membro del Consiglio di fondazione FIRSOL come rappresentante del Canton Ticino dal 2008, direttore della Divisione della cultura e degli studi universitari del Dipartimento dell'educazione, della cultura e dello sport. Ha sempre creduto nelle potenzialità dell'istituto, anche in momenti molto difficili attraversati dall'istituto. Il suo contributo si è dimostrato cruciale in più occasioni. La sua pacatezza accompagnata da forte determinazione hanno spesso permesso di acquisire il giusto atteggiamento per superare ostacoli.

2 PERSONALE

Organizzazione generale
L'organizzazione generale è diretta dal presidente della FIRSOL, Prof. Dr. Philippe Jetzer (Istituto di fisica dell'Università di Zurigo).

Direttorato
Dando seguito ai consigli espressi durante le valutazioni dell'IRSOL da parte di esperti internazionali e nazionali del Consiglio svizzero della scienza e dell'innovazione, la direzione dell'IRSOL è affidata ad un direttorio composto da:

Prof. Dr. Svetlana Berdyugina (direttrice del Kiepenheuer Institut für Sonnenphysik, KIS)

Dr. Michele Bianda

Prof. Dr. Jan Olof Stenflo

Staff scientifico

Dr. Luca Belluzzi (pure affiliato al KIS)

Dr. Michele Bianda

Dr. Edgar Carlin *)

Dr. Daniel Gisler (part time con il KIS)

Ing ETHZ Boris Liver

Dr. Renzo Ramelli (part time)

Dr. Oskar Steiner (part time con il KIS)

Prof. Dr . Jan Olof Stenflo, emeritus ETHZ, affiliato all'IRSOL

Prof. Dr . K. Nagendra, emeritus Indian Institute for Astrophysics, affiliato all'IRSOL

*) finanziato tramite il progetto del Fondo Nazionale, 200021_ 163405.

Staff amministrativo e tecnico

Katya Gobbi (segretaria)

Gianpaolo Mari

Dottorandi

MSc. Flavio Calvo **) (dal 1 novembre 2013)

MSc. Gioele Janett ***) (dal 1 settembre 2015)

MSc. Giovanni Privitera **) (dal 1 settembre 2012 al 30 settembre 2016)

Questi progetti di dottorato sono finanziati dal Fondo Nazionale.

**) Direttore di tesi: Prof. Dr. Georges Meynet dell'Università di Ginevra
***) Direttore di tesi: Prof. Dr. Mishra Siddhartha, SAM, Politecnico di Zurigo

Stages scientifici, lavori a tempo determinato

MSc. Giulio Mondia (dal 1 ottobre al 31 dicembre 2016)

Andrea Raso (dal 20 dicembre al 31 dicembre 2016)

Collaborazione con la SUPSI
In previsione dell'inizio del lavoro di Master come collaborazione SUPSI e IRSOL Andrea Raso ha iniziato uno stage all'IRSOL.

Collaborazione con l'Instituto de Astrofsica de Canarias (IAC)

MSc. Ernest Alsina Ballester (in visita all'IRSOL dal 3 aprile al 14 maggio) Dottorando all'IAC; il Dr. Luca Belluzzi è co-direttore di tesi.

Collaborazione con la Hochschule RheinMain di Wiesbaden Rüsselsheim
La collaborazione con la Hochschule RheinMain di Wiesbaden Rüsselsheim prosegue. Lavori puntuali sono sviluppati con il Prof. Dr. Gerd Küveler. Il Prof. Dr. Hans-Dieter Bauer segue lavori di Bachelor o di Master all'IRSOL; in particolare ha seguito:

Mathis Engelhard, lavoro di Master

Civilisti
Nel corso del 2015 hanno lavorato all'IRSOL:

MSc. Bruno Barbieri (dal 5 settembre al 28 ottobre)

Azeglio Diethelm (dal 11 luglio al 5 agosto)

MSc. Damiano Kuthan (dal 17 ottobre al 23 dicembre)

MSc. Giulio Mondia (dal 22 al 26 febbraio e dal 4 luglio al 16 settembre)

Dr. Alberto Paganini (dal 21 marzo al 8 giugno)

MSc. Filippo Paglia (dal 1 gennaio al 9 aprile)

MSc. Valentin Stadler (dal 9 settembre al 31 dicembre)

Ringraziamenti

l'11 novembre Giovanni Privitera ha difeso la sua tesi acquisendo il titolo di dottore in scienze naturali. Lo ringraziamo per aver lavorato intensamente per quattro anni in qualità di dottorando dell'IRSOL.

OBITUARIO

Purtroppo nel 2016 ci hanno lasciati persone che hanno avuto un importante ruolo nella storia dell'IRSOL.

- **Dr. Alessandro Rima 1920 - 03.07.2016†**

  Alessandro Rima, primo presidente della fondazione FIRSOL. Agli inizi degli anni 80 aveva fondato e diretto l'Associazione Specola Solare Ticinese che aveva permesso di continuare l'attivià scientifica della Specola Solare Ticinese. Informato della decisione di chiudere l'Istituto Ricerche Solari Locarno si era impegnato nell'operazione che avrebbe permesso lo sviluppo dell'IRSOL sotto la gestione della fondazione. Aveva creduto fermamente in questa idea, circondandosi anche di persone competenti quali Paul Utermohlen, già alto funzionario della ditta olandese Philips, e l'attuale presidente della fondazione Philippe Jetzer. Rima aveva impostato le linee guida per la gestione dell'operazione permettendo di superare notevoli difficoltà iniziali. Quale esempio della sua determinazione va ricordato che si era impegnato personalmente anticipando l'importo necessario per l'acquisto dell'istituto.

- **Karl Heinz Duensing 1925 - 28.12.2016†**

  Karl Heinz Duensing, in qualità di capo officina dell'Osservatorio Universitario di Göttingen aveva diretto la costruzione del telescopio dell'IRSOL. Alla fine degli anni 80, saputo dell'operazione di salvataggio dell'IRSOL, si era messo a disposizione per ricostruire pezzi del telescopio di Locarno smontati per essere utilizzati sul nuovo telescopio di Tenerife, alle Isole Canarie. D'accordo con la direzione dell'Osservatorio di Göttingen aveva potuto utilizzare l'officina universitaria per costruire i pezzi mancanti, aggiungendo però sue innovazioni la cui utilità era emersa nel precedente periodo di utilizzo a Locarno. Avevamo dunque a disposizione una versione aggiornata rispetto a quelli installati sullo strumento di Tenerife. Nella fase di ricostruzione aveva trascorso molte settimane all'IRSOL per eseguire critici lavori di ripristino e per istruire Bianda sulle modalità per completare i lavori. Si era in seguito sempre interessato degli sviluppi dell'IRSOL proponendo suggerimenti tecnici.

- **Ivano Beltrami 1951 - 11.1.2017†**

  Ivano Beltrami era stato nominato nel 2013 quale rappresentante del Canton Ticino nel consiglio di fondazione della FIRSOL. Aveva seguito da vicino i temi che implicavano rapporti tra IRSOL e la SUPSI, permettendo un rafforzamento ulteriore con questo ente universitario.

3 SCIENTIFIC WORK

The overall goal of the scientific activity carried out at IRSOL is the investigation of the magnetic fields present in the solar atmosphere. Solar magnetic fields can be investigated by analyzing the signatures that they leave, through different physical mechanisms, on the polarization properties of the electromagnetic radiation. In general, the development and application of a given diagnostic method requires:

a) to model the generation and transfer of polarized radiation in the solar atmosphere, taking the above-mentioned mechanisms into account, so to identify specific polarization signals containing the desired information on the magnetic fields;

b) to develop instruments capable to observe such signals, and performing precise observations;

c) to compare the observed signals with the results of theoretical calculations performed in realistic simulations of the solar atmosphere.

Activity in our research field is thus based on three main "pillars": theoretical modeling; observations and instrumental development; numerical simulations of the solar atmosphere. At IRSOL, we have today expertise in all these pillars, and specific research projects are presently carried out in each of them.

From the instrumental point of view, IRSOL is the home basis of ZIMPOL, one of the world leading instruments in the field of high-precision solar spectropolarimetry. Since 2015, the maintenance and further development (see Sect 4.1) of this instrument is fully carried out at IRSOL.

Observations performed both at GREGOR and at IRSOL are at the basis of works reported in the following sections.

A brief description of the scientific works and projects that are presently carried out at IRSOL is provided below. The projects are divided in different groups, depending on their main topic. Of course this grouping is only indicative, since most of the projects may touch different aspects of the problem: theoretical, computational, and observational.

3.1 Physics of polarization and theoretical interpretation of peculiar signals

3.1.1 Observation and Interpretation of anomalous double-peak V/I signals in strong chromospheric lines

During the last few years, while performing a series of observations of the scattering polarization signals of the Na I D_1 and D_2 lines, within the framework of other reserach programs, we noticed the appearance of anomalous V/I polarization signals, presenting two symmetric peaks of the same sign. These signals generally appeared in relatively quiet regions, close to the limb, and could be observed with ZIMPOL both at IRSOL and at GREGOR. Once we could fully confirm their solar origin, we submitted a project focused on their observation and theoretical modeling to SNF. The project was financed and allowed us to offer a two-year post-doctoral position (1.11.2015 - 31.10.2017) to Dr. E.S. Carlin.

During 2016, Dr. Carlin worked on the identification of possible mechanisms that could be able to produce this kind of signals. To this aim, he has studied different theoretical schemes capable of describing the physical effects of interest (e.g., hyperfine structure, lower-level polarization, partial

frequency redistribution effects), analyzing their advantages and limitations. He has identified the symplifying hypotheses that can be considered, and has started the development of the numerical tools that are need for their modeling in realistic models of the solar atmosphere. Particular attention is being focused on the modeling of the temporal evolution of the polarization signals, and on the impact of macroscopic velocities, in continuity with the previous work on the Ca I line at 4227 Å.This activity is still ongoing, taking also into account the indications provided by the new observations.

From the observational point of view, extremely interesting results could be obtained during the 2016 campaign at GREGOR (see Sect. 3.5.1). Indeed, the same kind of circular polarization signals, which up to that time had only been observed in the Na I D-lines and, much less frequently, in the Ba II line at 4554 Å, could be observed, for the first time, in a series of Fe I lines at around 4900 Å. This finding provides important hints for the theoretical work. For example, we have now indications that hyperfine structure (which was initially considered as a possible key physical ingredient) does not necessarily play a major role in the origin of such signals.

3.1.2 Investigation of the enigmatic signals observed in the NaI D1 line

The theoretical interpretation of the enigmatic scattering polarization signal observed by Stenflo & Keller (1997, A&A, 321, 927) in the core of the Na I D_1 line is, since many years, one of the most debated topics in solar spectropolarimetry. The detection of this signal is certainly a challenging task, and ZIMPOL keeps representing the best instrument today available for its observation with high polarimetric sensitivity and high spectral resolution. At IRSOL, a considerable amount of data about this signal has been collected during the last years, and it is now one of our priorities to analyze in detail such data, and to present the results to the international community. Indeed, the results of this analysis will be of great interest for the theoretical work. For instance, it will be extremely interesting to compare them to the results of the theoretical modeling that has been recently proposed by Belluzzi & Trujillo Bueno (2013, ApJL, 774, 28), and Belluzzi et al. (2015, ApJ, 814, 116).

During 2016, we have started developing a series data-analysis computer routines, implementing mathematical tools for extracting the D_1 signal from the noise. Particular attention has been focused on non-parametric kernel regression techniques and spline smoothing. Most of this work has been carried out by MSc. Valentin Stadler, during his civil service period at IRSOL (September 2016 - January 2017), under the supervision of Luca Belluzzi. These techniques will be now applied to the observational data, so to make a statistical analysis of the occurence rate of a clear scattering polarization signal in the core of this line, as well as of its amplitude, shape, and wavelength position.

This work is one of the main goals of the project recently submitted by Luca Belluzzi to SNF.

3.1.3 Forward scattering Hanle effect in the Ca I line at 4227 Å

The project was concluded in 2015 and is described in Sec. 3.4.1 of last year report. Important concepts developed in this project has shown to be crucial in the new project described in Sect. 3.1.1. In 2016 a publication apperaed showing how time evolution and macroscopic velocities affect the Ca I 4227 Å Hanle signals forming in the low chromosphere (Carlin and Bianda, 2016). A further one is in the revision process.

3.1.4 Development of the theory of polarized scattering in collaboration with the group of Professor K.N. Nagendra in Bangalore

IRSOL has since many years an ongoing collaboration with the theoretical research group of Professor K.N. Nagendra in Bangalore, India. The aim is to systematically develop the theory of polarized scattering in magnetized media together with Jan Stenflo and to apply this theory to the interpretation and modeling of observations carried out with ZIMPOL at IRSOL. As part of this collaboration scientists from the Bangalore group have had extended research visits to IRSOL at several occasions, and Stenflo has co-guided the PhD thesis projects that have been carried out in Bangalore. During 2016 two of these thesis projects were successfully completed, by K. Sowmya and H.D. Supriya. They, like all the previous PhD students of the Nagendra group, have since received postdoc positions at prestigious institutes in different countries, where they continue their research on solar polarization as well as their research contacts with IRSOL.

3.1.5 Laboratory tests of the theory at INLN in France

One new aspect of the systematic development of the theory of polarized scattering of radiation is to explore the foundations of quantum scattering theory by laboratory experiments. A first set of such experiments, which were carried out within Stenflo's group at ETH more than a decade ago, revealed unexpected polarization signatures, which could not be explained within the framework of existing theories. In a series of papers (the latest of which was published in the fall of 2016) Stenflo has tried to identify the missing physics and extend the scattering theory in a consistent way. In parallel with these efforts a collaborative program with the Institut Non-Lineaire de Nice (INLN) in France has been initiated, where they have the facilities to experimentally test such scattering theories. For the implementation of such an experiment, INLN has borrowed from IRSOL a piezoelastic polarization modulator. During 2016 a French student was hired to try to set up the novel experiment, make test observations and gain experience with it. Based on this experience the plan is now to do this experiment in the form of a new PhD project at INLN. The senior scientists from Nice who are involved in this collaboration are R. Kaiser and W. Guerin at INLN and M. Faurobert at Observatoire Cote d'Azur. It is foreseen that the Nagendra group of Bangalore, in collaboration with Stenflo, will be involved in the theoretical analysis of the experimental data.

3.2 Numerical modeling of the generation and transfer of polarized radiation

3.2.1 Partial frequency redistribution in scattering polarization; PhD work of Ernest Alsina Ballester

The PhD work of Ernest Alsina Ballester (thesis carried out at IAC, under the co-supervision of Dr. Luca Belluzzi and Prof. Javier Trujillo Bueno) has successfully advanced during 2016. The topic of the thesis is the radiative transfer modeling of the combined action of the Hanle and Zeeman effects produced by magnetic fields of arbitrary intensity and orientation, taking partial frequency redistribution (PRD) effects into account. One of the most remarkable results of the work carried out in 2016 is the discovery of the strong impact that magneto-optical (MO) effects have on the large scattering polarization signals that PRD effects produce in the wings of strong resonance lines, such as the Mg II k line at 2795 Å. This result has been published first in a letter (Alsina Ballester et al. 2016, ApJL, 831, 15), and then in a more detailed paper (Alsina Ballester et al. 2016, ApJ, 836,

6). It has also been presented at the international Solar Polarization Workshop 8, held in Florence (Italy) in September 2016. As in the previous years, also during 2016, MSc. Alsina has spent regular periods at IRSOL.

3.2.2 Development of a 3D non-LTE radiative transfer code taking PRD effects into account

One of the big challenges in our research field is to model scattering polarization and the combined action of the Hanle and Zeeman effects in realistic three-dimensional (3D) models of the solar atmosphere, taking PRD effects into account. The possibility of performing this kind of modeling would represents a key step in the development of new diagnostic techniques for the investigation of the magnetic fields in the outer layers of the solar atmosphere (chromosphere and transition region). The main difficulty in the achievement of this goal is of computational character, and a synergetic approach, complementing expertize in different fields (theory of polarization, non-LTE radiative transfer, computational sciences), is absolutely required.

In 2016, we decided to try to cope with such an ambitious project, submitting a proposal to SNF, within the framework of the "Sinergia Program". Three applicants, each leading a different working group, were involved: Dr. Luca Belluzzi (IRSOL, main applicant), Prof. Rolf Krause (Institute of Computational Sciences, USI, Lugano), and Prof. Javier Trujillo Bueno (IAC, Tenerife, Spain). Dr. Jiri Stepan (Ondrejov observatory, Academy of Sciences of the Czech Republic) was also involved as partner, given his great expertise in solving the same kind of problem, but in the limit of complete frequency redistribution (CRD). Unfortunately, the project was not financed, although two referee reports (over three) were clearly positive, and the SNF commission recognized the imortance of the topic, as well as the suitable expertise of the various groups involved. In 2017, we plan to submit again a proposal, trying to improve it following the indications of the refrees. The project would allow us to open three post-doctoral positions (one in each institution) of four years each.

An interesting work concerning numerical aspects of the PRD problem described above (but in 1D) has been carried out by Dr. Alberto Paganini, during his civil service period at IRSOL (21.3.2016 - 8.6.2016), under the supervision of Luca Belluzzi. Dr. Paganini could optimize the numerical calculation of the so-called "angle-averaged" approximation of the redistribution matrix. A collaboration with Dr. Paganini (presently post-doc at the Oxford University) on this topic is still ongoing. A publication on the results of this work is in preparation, and we cannot exclude that some of the ideas and methods that have been analyzed within the framework of this collaboration might be of interest also for solving the problem in 3D.

3.2.3 Radiative transfer in discontinuous media; PhD work of Gioele Janett

MSc. F. G. Janett carries out research work at IRSOL for a PhD-thesis in view of a PhD-degree from ETH-Zürich. In the present report period, he carried out a thorough numerical analysis of conventional and alternative methods for the formal numerical integration of the radiative transfer equation for polarized light. The advantages and drawbacks of the existing different formal solvers have been characterized based on the concepts of order of accuracy, stability, and computational cost. In a first paper, special attention is paid to understand the numerical methods belonging to the Diagonal Element Lambda Operator (DELO) family. A second paper (presently in preparation) focusses on high-order methods. MSc. G. Janett gave an oral presentation on this subject at the

Solar Polarization Workshop 8 that took place in Florence and he presented a poster at the Platform for Advanced Scientific Computing Conference (PASC16) in Lausanne.

3.3 Development and application of new diagnostic techniques

3.3.1 The CLASP project

The CLASP-1 and CLASP-2 experiments The work of theoretical interpretation of the observations carried out by the "Chromospheric Ly-Alpha Spectro-Polarimeter" (CLASP-1) sounding rocket experiment has continued during the whole 2016. Large part of this work has been carried out by the CLASP theory team, which is formed by scientists from IAC (Spain), ASCR (Czech Republic), and IRSOL. A particularly interesting aspect, considered by L. Belluzzi (IRSOL), J. Trujillo Bueno (IAC), in collaboration with their PhD student E. Alsina, concerns the modeling of the variations of the Q/I and U/I polarization signals observed in the wings of the hydrogen Ly-alpha line. Indeed, it is interesting to understand whether these variations are only produced by symmetry-breaking effects due to the geometrical complexity of the plasma, or if they are dominated by the magneto optical (MO) effects found by Alsina Ballester et al. (2016; ApJ Letters) in the Mg II k line (see Sect. 3.2.1). A series of publications on the CLASP-1 observations, as well as on their theoretical interpretation, have been prepared during 2016 and are now appearing in international journals.

The success of CLASP-1 has led the same international team of scientists to propose a new experiment, the "Chromospheric Layer Spectro-Polarimeter" (CLASP-2). CLASP-2 will be focused on the Mg II h and k lines at 2800 Å, motivated by the theoretical work of Belluzzi & Trujillo Bueno (2012, ApJ Letters). It will be a collaboration among the national spatial agencies of USA (NASA) and Japan (JAXA), and several European Institutes including IRSOL. In December 2016, the project has been approved by NASA. The launch is scheduled in 2019.

The theoretical modeling of scattering polarization in the Mg II h and k lines, in the presence of magnetic fields of arbitrary intensity and orientation, taking into account PRD and MO effects, is one of the goals of the PhD Thesis of E. Alsina (see Sect. 3.2.1).

3.3.2 Synoptic program to measure the evolution of the photospheric magnetic field during a solar cycle

Since 2007 we carry out a synoptic program to explore if the magnetic flux of the quiet photosphere varies with the solar cycle. For this purpose we apply a differential Hanle effect technique based on observations of scattering polarization in C_2 molecular lines around 514.0 nm, taken generally every month. Our results now span almost one complete solar cycle.

Even though it is not easy to appreciate long term variations, a new analysis performed in 2016 and presented at the Solar Polarization Workshop 8 in September seem to show a slight correlation with solar activity. These results tend to indicate that the turbulent unresolved magnetic field strength is slightly dependent on the solar activity. A more detailed interpretation and analysis of the results is still in progress. If the correlation is confirmed, the collection of additional data in the future could increase the significance of the result.

3.4 Investigations based on MHD simulations (also on stellar physics)

3.4.1 Magnetohydrodynamic solar model atmospheres; PhD work of Flavio Calvo

MSc. F. Calvo carries out research work at IRSOL for a PhD-thesis in view of a PhD-degree from the University of Geneva. In the present report period, he continued computing three-dimensional magnetohydrodynamic solar model atmospheres, using computational resources at CSCS in Lugano. He used these models for the subsequent synthesis of spectropolarimetric maps serving for the interpretation of polarimetric measurements. Of particular interest are theoretical predictions regarding the center-to-limb variation of the continuum polarization, which is presently measured at high polarimetric precision at IRSOL. The synthetic polarimetric maps were confronted to previous lower-resolution maps and to the best observations presently available. A publication about this subject is in preparation and MSc. F. Calvo gave an oral presentation on it at the Solar Polarization Workshop 8 that took place in Florence. In parallel, he synthesized spectroloparimetric maps for the line pair Fe I 630.151 and Fe I 630.250 nm and other lines in order to investigate the Stokes-V line ratio method, used to retrieve the line-of-sight magnetic field strength. To this aim he visited the Instituto de Astrofísica de Canarias for a collaboration with Dr. R. Rezaei and for the post-processing of the data. He also carried out investigations about the structure of the Balmer jump in the continuous solar spectrum. The study of intriguing photometric bright points due to swirling downdrafts in the intergranular space lead to a publication in the *Astronomy & Astrophysics* scientific journal. MSc. F. Calvo gave an oral presentation of this subject at the CO5BOLD user workshop in Napoli.

3.4.2 Waves in magnetic flux tubes and small-scale magnetism of stellar atmosphere

With the help of radiation magnetohydrodynamic simulations of the solar atmospheric layers from the upper convection zone to the lower corona, we investigated the self-consistent excitation of slow magneto-acoustic body waves in magnetic flux concentrations (O. Steiner with Y. Kato et al.). Likewise, we investigated gravity waves in the solar atmosphere in dependence on the presence or absence of magnetic fields. It was shown that the presence of magnetic fields suppresses the propagation of gravity waves into the higher photosphere and the chromosphere (O. Steiner with G. Vigeesh and J. Jackiewicz). Observations with the balloon born solar telescope Sunrise have revealed high frequency oscillations of high phase speeds of 30 $\mathrm{km\,s^{-1}}$ in small magnetic elements of the solar atmosphere. We conjecture that the refraction of fast longitudinal waves may explain the high phase speed (O. Steiner with S. Jafarzadeh et al.).

Numerical simulations of magneto-convection in the surface layers of stellar atmospheres of spectral types K to F have been performed and the influence of the small-scale magnetic field on the luminosity variation was analyzed. (O. Steiner with R. Salhab).

3.5 Observational projects

3.5.1 Observations campaign at GREGOR

In October we performed an observation campaign at GREGOR in Tenerife using ZIMPOL. The recently installed image derotator allowed us to overcome the problem we were faced during the last campaigns, when the rotation of the solar image did not allow long observations keeping the image stable on the spectrograph slit. As a consequence it was not possible to maintain the spatial resolution over the long observations required to achieve high polarimetric precision.

During our last campaign we had several sunny days, but only few hours of good seeing, that was used to perform observations in the Sr I 4607.3 Å line. This work is motivated by the theoretical predictions of Trujillo Bueno and Shchukina according to which the amplitude of the scattering polarization signal of this line should show clear variations when observed with a spatial resolution below 1 arcsec, so to clearly distinguish the details of the solar granulation. Our observations could resolve the granulation and we could detect the expected amplitude variations of the scattering polarization peak. Nevertheless the theoretical interpretation of these data needs further insights. These observations are also the target of a project financed by SNF (see Sect. 3.5.3).

In despite of the not excellent seeing conditions, it was possible to verify that the adaptive optics system of GREGOR allows to observe with the spectrograph close to the solar limb keeping the distance from the limb to the spectrograph slit constant. That allows very precise center to limb variation observations, with an accuracy below one arcsecond, despite of the loss of spatial resolution along the spectrograph slit direction. This property was used to observe several chromospheric lines related to the project 3.1.1.

With this campaign we could verify that a spatial resolution better than 1 arcsec can be achieved for high precision spectropolarimetric observations. Another conclusion is that even without good seeing it is still possible to perform high quality spectropolarimetric observations close to the solar limb.

3.5.2 Atlas of the Suns center-to-limb intensity spectrum variation (CLV)

This project started several years ago, and required long observation and data reduction time. This work was mostly accomplished through semester, Bachelor or Master works. The different contributions were merged by MSc Filippo Paglia who did his civil work at IRSOL. The final results are now ready and will be published in 2017 on our web site.

In the wavelength interval from 439 nm to 638 nm, the following data, measured at IRSOL, are available: the spectral intensity profile measured at disk center, ratios of intensity profiles measured at at $\mu = \cos\theta$ going from 0.1 to 0.9 (with θ the heliocentric angle) and at disk center. The information of the center to limb variation of the intensity in the solar spectral lines, that can be extracted from these data, has applications in many fields. For instance it is possible to study the illumination anisotropy in the solar atmosphere producing the scattering polarization measured near the limb(second solar spectrum). The data provide also a benchmark for many numerical models.

3.5.3 Feasibility study for an instrument measuring granular scattering in the SrI 4607 Å line

In collaboration with NSO and KIS we are planning to study the feasibility of measuring and exploiting the variation of the Sr I 4607.3 Å line polarization inside the granulation (see 3.5.1). The project was submitted to SNF, in particular a financing was required for the exploring phase that foresees the test of a prototype instrument in Tenerife using GREGOR. The financement for a PhD student and a postdoc was granted.

During our GREGOR campaign one of the main goals was to verify the existence of the theoretically predicted spatial variation in the Sr I line (see Sect. 3.5.1). The result was sucessful: the predicted signtures were measured.

In September we had the visit of scientists working at the DKIST project (D. Harrington and S. Svedoca), it was possible to draft very preliminary and general ideas about a possible location of the instrument.

3.5.4 Center-to-limb variation (CLV) of continuum polarization

Precise measurements of the center-to-limb variation of continuum polarization are required by several projects in solar and stellar astrophysics. However, these kind of measurements are very challenging because of the small signals and various disturbing instrumental effects. 2013 together with KIS we started a measurement project at IRSOL and since then we continually improve the measurement method to increase the precision of the results. In the previous year a new method has been introduced consisting of a rotary retarder film mounted in front of the telescope. 2016 with this method we got improved results but the measurement where very time consuming and inefficient because of manual operation of the retarder. A new motorized device had to be constructed to solve the problem (see sect. 4.32.3).

3.6 Specola Solare Ticinese

Scientific work at Specola Solare Ticinese is focused on the determination of the solar index data, or Wolf number, Ri. In this respect, Locarno is the reference station of Solar Influences Data Analysis Center, SIDC, in Brussels. The experience of Sergio Cortesi, who worked under the direction of Max Waldmeier starting in 1957 till 1980, gave continuity in the counting method defined in Zurich from Rudolf Wolf in the mid 1800s. This know-how has been transmitted to Marco Cagnotti.

The counting method used in Zurich until 1980 and at Specola Solare Ticinese was never described in a clear way in a scientific publication. To fill this missing information we described the details in the paper of Cortesi et. al. (2016).

In 2016, 280 drawings were performed; the drawings and the calculated Wolf number can be seen on the web (www.specola.ch).

IRSOL staff collaborates with Specola for outreach activities and, in case of need, for the execution of the solar drawings and their reduction. Ramelli acts also as WEB master for the Specola WEB pages.

The Sunspot Number (SSN) time series, for which Specola is presently the world reference station, got in 2016 an important international recognition. In fact the SSN was included in the new implementation plan of the Global Climate Observing System (GCOS), considering the high correlation with the total solar irradiance (TSI). The direct measurement of the TSI is performed by satellites since only 4 decades, while the SSN that covers more than 4 centuries allows to reconstruct the TSI much more back in the past. In this context Renzo Ramelli gave a talk about the role of Specola observing activty at the Swiss GCOS roundtable on 28th January 2016. We acknowledge the support given by Paolo Ambrosetti and Marco Gaia for the action that promoted the role of the SSN within GCOS.

3.7 Stellar physics

3.7.1 Planet engulfing scenarios in extra-solar systems; PhD work of Giovanni Privitera

This topic was the thesis work of Dr. Giovanni Privitera, followed by Prof. Dr. Georges Meynet at Geneva Observatory. The work was successful as can be seen in following extract of the report sent by the members of the jury to the Dean of the Faculty of Science at Geneva university.

The orbit of a planet can significantly change in the course of time. Due to tidal forces between the star and the planet, exchanges between the orbital angular momentum of the planet and the rotational angular momentum of the star can occur. When the orbit of the planet is inside the corotation radius, these tidal interactions tend to transfer angular momentum from the orbit to the star. That means that the distance between the planet and the star decreases and the rotational velocity of the star increases. The inverse occurs when the orbit of the planet is beyond the corotation radius. The corotation radius is the distance at which the orbital period of the planet would be equal to the rotation period of the star (synchronised system).

Much work has been done in the past to deduce the evolution of the planets in the solar systems and more generally of planets around stars of different initial masses, metallicities. One interesting conclusion of many of these works is that for planets orbiting sufficiently near their host star during the main sequence, the tidal interaction will lead to the engulfment of the planet when the star becomes a red giant. When this occurs, models indicate that changes at the stellar surface could be observed: a transitory and rapid increase in the luminosity (Siess & Livio 1999b), a change in the surface abundance of lithium (Carlberg et al. 2010; Adamow et al. 2012) or an increase of the surface rotation rate (Siess & Livio 1999ab; Carlberg et al. 2009, 2010). Interestingly some stars present observed characteristics that could be related to planet engulfments as for instance the few percents of red giants (RGs) that are fast rotators (Fekel & Balachandran 1993; Massarotti et al. 2008; Carlberg et al. 2011, Carlberg 2014).

The main objective of the thesis of Giovanni Privitera was to identify, from theoretical models, some non-ambiguous signatures for tidal interactions/engulfment to have occurred and then to check whether these features are indeed observed. The main result of this study can be found in three published papers in Astronomy & Astrophysics. The first one (Privitera et al. 2016, A&A, 591, A45) linked the stellar evolution code of Geneva Observatory with a program computing the evolution of the orbit of a planet. Mr. Privitera studied how the planetary orbit evolved together with the angular momentum of the star under the action of tidal forces. He determined the initial conditions (i.e. masses of the star and the planet, distance between them at the ZAMS, Zero Age Main Sequence) leading to a planet engulfment during the red giant branch. He focused on the case of engulfment during the red giant branch because he wanted to know to which extent the few percents of fast rotating red giants could be due to a planet engulfment. We would like to emphasize here that these models were the first ones where a real coupling between rotating stellar models and an orbiting planet has been performed. Previously such studies were done based on very rough assumption concerning stellar rotation, for instance assuming solid body rotation, while it is known that for instance red giants are not rotating as solid bodies (Beck et al. 2012; Mosser et al. 2012; Deheuvels et al. 2012, 2014). In this first paper, he obtained that these tidal interactions can already significantly increase the surface rotation of red giants.

The surface rotation is still increased when the planet engulfment occurs. Planet engulfment is the topic of the second paper (Privitera et al 2016, A&A, 593, A128). Giovanni Privitera showed that the acceleration of the star due to an engulfment may bring the surface velocities to high values

that cannot be reached without any interaction with a second body. Said in other words, he showed that a single star with no planet starting its evolution with the highest possible angular momentum content cannot reach these high surface velocities during the red giant phase. It happens that red giants with such high surface velocities are observed. This study thus shows that these stars should have interacted with a companion in the past.

Giovanni Privitera also studied to which extent other observable signatures as changes of the surface abundances might result from such an engulfment. Surface enrichment in lithium (Li) appears as a possible outcome of a planet engulfment, but Li is a fragile element and the signature is by far non-ambiguous. Thus the surface velocity does appear at the moment as the best signature of a planet engulfment.

In the last and third paper (Privitera et al. 2016, A&A, 593, L15, this paper was accepted as a letter), he explored the possibility that a planet engulfment might activate a dynamo and produce a strong surface magnetic field. Using semi-empirical relations linking surface rotations, properties of the external convective zone and surface magnetic fields, he made predictions for the surface magnetic fields of red giants having engulfed a planet. He showed that planet engulfment might produce strong surface magnetic fields in the upper part of the red giant branch where one would expect no surface magnetic field from stars with no planets. Thus he identified a new observational feature. An observing time proposal to check this result with spectropolarimetry has been submitted in collaboration with Prof. Gregg Wade (Canada) who is a world leading expert in stellar magnetic field measurement.

3.8 Education

O. Steiner gave a lecture entitled "Why MHD simulations" at the 5th SOLARNET[1] Summer School "Waves and Oscillations in the Solar Atmosphere" in Belfast (UK).

At IRSOL we give young students the opportunity to take a look at a research institute, because that can generate interest for a scientific educational path. Every year, in collaboration with the cantonal education administration, we give the opportunity to young students to perform a one day stage before they start the high school. Moreover we offer support for maturity works with astronomical topics. In sub-chapter 6.5 are listed works performed in collaboration with IRSOL.

Within our long ongoing collaboration with the University of Applied Sciences Wiesbaden Rüsselsheim, this year a Master work was sucessfully performed by MSc. Mathis Engelhard (see 4.2)

IRSOL promotes an outreach program together with Specola Solare Ticinese, organizing observation events supervised by an astronomer.

4 TECHNICAL WORKS

4.1 ZIMPOL project

4.1.1 ZIMPOL Camera hardware

The development of the camera's hardware was split into two main branches of improvement.

[1]SOLARNET is part of the 7th framework program of the European Union

- The first system is intended to be retro compatible with the existing set of boards, considering connectors, signals and mechanical layout that may be interchanged. Only a few new signals were introduced, especially those to identify the components and to measure temperature, pressure and humidity in the sensitive parts of the assembly (SPI bus). To keep functional compatibility, the core FPGA is migrated from Altera's Cyclone-I family (EP1C6Q240C8N) vertically to an almost pin-to-pin compatible replacement of the Cyclone-III family, which is the latest generation that still implements the QFP-240 package and it's possible to assemble the components on board without any special tools (traditional solder iron). The chosen technology is EP3C40Q240C6N, which mainly has six times more LE (logical elements), is about two times faster and allows the implementation of a more complex timing engine, which replaces the former implementation of the TSP-1.0. With this technology and speed class, the upper limit possible is 250MHz fast clock and using DDR (double data rate) a time resolution of 2ns (corresponding virtually to 500MHz) can be achieved. Moreover the master system clock was synchronized between CPU (50MHz) and FGPA (former 48MHz resulting in odd 20.83ns cycles, now 50MHz), in order to avoid the slow VLIO (variable latency I/O) interface and use a uniform clock instead. Finally the design of electronically adjustable bias voltages for the sensor is studied in order to be able to software fine tune the optimal operating point of the CCD. The implementation is pending to be validated on a new CCD interface board, which will be made in 2017.

- A second new system, developed side by side with the above concept, is mostly redesigned in sight of using the Cyclone-V SoC. Basic testing was done on the DENX evaluation board, creating a fully functional system based on buildroot toolchain. This system is functionally interchangeable with the first one, but mechanically has a new form factor. As we currently don't have the tools to build an own board, including any Cyclone-V component (lack of tools to solder large BGA chips, no experience in DDR3 interface), an alternate platform was built around the EP4C22E22C6N component, which has similar power as the Cyclone-V but does not implement the ARM core. An external ARM core was chosen, with equivalent features, which is the RaLink 5350 that can easily be bootstrapped from SPI flash, load a Linux kernel, and run the system with one single SDRAM. The prototype schematics are taken from the HiLink HLK04 family of small SoM. The main advantage of this core is the internal ethernet peripheral (MAC and PhY) and plenty of GPIOs.

We succesfully produced in house a working FPGA-based board based on EP4C22E22C8N, the main goal of this assembly is to modulate a LED matrix (16 x 8) with a time resolution of 500ps (Cyclone-IV can work with QDR (quad data rate) using 90 phase shift from the internal PLL running up to 1GHz). At the end of 2016 a resolution of 1ns was tested and stable. Further enhancement can be achieved using the EP4CGX15BN11 family, which SERDES is RGMII-capable (the ethernet MAC can be integrated into the FPGA fabric) and being smaller, higher data rates can be obtained.

An initial study of how to manage clock synchronisation when using the PEM as timing reference was also done. The main idea behind this modification is to use the external PEM oscillator as the only and a main time base for the whole system. Once the FPGA detects that the external PEM frequency is stable, in switches it's internal PLL to this clock source, calculating the appropriate multiplier in order to obtain a master clock as close as possible to 50MHz, keeping it an integer factor of the PEM. This simplifies all internal timings because there is no more phase shift between the demodulator and the AFE sampling frequency.

4.1.2 ZIMPOL Camera firmware

The firmware of ZIMPOL was reduced and compacted to an easy-to-maintain system totally build from open source. This is a mainstream kernel built from the buildroot toolchain, including the Colibri-BSP, an essential version of uClibC and Das U-Boot as the bootloader. Also time synchronisation was improved using the XNTP protocol and setting the internal time base to UTC for all components of the system.

Loading of the TSP code is integrated in the main program (Z3Server) and the hardware kernel drivers are optimized for efficient data handling between user and kernel space.

4.1.3 ZIMPOL Camera software

The ZIMPOL command interface is rewritten, using a new command and syntax parser. All useless debugging commands are removed and new diagnostic and remote debugging features are added. Especially an active TCP/Telnet client is now embedded into the Z3server code, which allows the camera to actively send debugging information to an external SYSLOG server. This feature is important to be aware of any malfunctioning of the device in real time.

Version checking and auto-update possibilities make it easy to validate new versions of the software without need to reprogram the camera, as the beta versions can be loaded into a temporary file system (ramdisk) and executed from there, without the need to rewrite and wear out the internal flash memory.

4.2 Fabry Perot filter

The CSIRO lithium niobate Fabry-Perot etalon filters at IRSOL were used for spectropolarimetric observations using ZIMPOL 2 (Kleint, L. et al., 2011, A&A, 529, 78). The upgrade of the system to be used with ZIMPOL 3 was the Masters topic of Mathis Engelhard (Hochschule RheinMain) supervised by Prof. Hans-Dieter Bauer and Dr. D. Gisler.

The work was successful, Engelhard could migrate and improve the existing codes and algorithms. As before, we are using a combination of the Fabry-Perot etalons with the spectrograph of IRSOL. The advantage of the design is that no narrowband prefilter is needed, thus virtually any wavelength from 390 nm to 660 nm can be observed. The disadvantage is that along a direction (corresponding to the spectral direction) there is an image degradation corresponding to the linear dispersion of the grating. The new optical design has some improvements; in order to decrease the number of optical components in the optical path, the image derotator device is removed. The image rotates on the ZIMPOL CCD sensor, but the effects can be calculated and taken into account in the data reduction. That also reduces or eliminates the effects due to telescope and derotator optics misalignment.

The work of Engelhard, due to time limitations, could not include a detailed and user friendly manual. That was delivered by MSc. Damiano Kuthan during his civil service at our institute. It was also possible to improve some algorithms and trying successfully a configuration where the polarization plane of the beam is rotated by 90°, that removes blind wavelength intervals.

A Master work in collaboration with the Ecole polytechnique fédérale de Lausanne EPFL is foreseen in 2017. The topic will be on 2D spectropolarimetric observations of prominences using the Fabry-Perot filters.

4.3 Instrumentation miscellaneous

- A new device, the telescope calibration unit (TCU), has been constructed. It consists of a large motorized rotary stage with the size of the full telescope aperture. Different polarizer and retarder films can be mounted to either create any state of fully polarized light or modified the incoming polarization state. The TCU will be used to measure the polarization crosstalks introduced by the telescope or for special measurement methods to cancel out small instrumental errors. Especially the TCU will permit to perform in an automatic way the observations required in the project 3.5.4.

- The heat rejection element at F1 of the telescope, used to select the 200 arcseconds field of view, is water cooled. In order to avoid water circulation in the telescope we are looking for alternatives. A test using heat pipes normally used for the cooling of the CPU in computers showed the strengths and the limits of the technique.

4.4 Network and Computer infrastructure

- The layout of the IRSOL WEB pages has been redesigned and upgraded. The main webpages are now managed through a CMS platform based on WordPress, while the former version was based on direct editing of the html code.

- During the two months spent at IRSOL in the framework of the civil service, the software engineer Bruno Barbieri installed on the IRSOL WEB system a new interface for a more comfortable handling of the publication list of the institute. Furthermore he developed a new interface for registering the sunspot data collected at the Specola Solare in a database.

- We have begun the migration from ethernet to PoE++/LTPoE++ were powered devices are suitable (sensors, actuators); while fibers are introduced in the LAN were only the data bandwidth between the machines is leading.

- Two new NAS (network attached storage) extended the storage capacity of our data center, with a total capacity of 2x 15TB. One is dedicated for scientific data storage (raw and reduced measures from the ZIMPOL system), the other acts as a data server for documentation, installation, software and firmware. The latter device also implements TFTP boot services to bring up diskless guest workstations, which are more and more flexible and maintenance-free.

- We are planning to add also a GIT-Server for software versioning and tracking, and have a working iPXE network boot and centralized OS provisioning system in our LAN, in order to reduce IT support overhead. Offering a uniform way to install software applications and tools, also avoiding internal incompatibilities due to different flavours of the used programs and protocols.

4.5 Infrastructure work

- The conformity to the current national regulations of the institute electrical system was verified by an expert. A list of works to improve the system in 2017 was redacted. The actualization of the electric plans of the institute proceeds (G. Mari)

5 LAVORI PREVISTI NEL 2017

- **Associazione con l'Università della Svizzera Italiana** La domanda al Fondo Nazionale sul progetto riportato al punto 3.2.2 verrà risottomessa tenendo conto dei suggerimenti espressi dagli esperti.

- **Sviluppo del programma scientifico**

  Buona parte dei progetti descritti al capitolo 3 verranno approfonditi ulteriormente nel corso del 2016.

- **Inizio del progetto di misure 2D nella riga Sr I**

  Come descritto al punto 3.5.3 il progetto partirà quando il postdoc e il dottorando previsti nel progetto accettato dal Fondo Nazionale saranno operativi. Il lavoro verrà coordinato con il Kiepenheuer Institut di Freiburg e con il Nationa Solar Observatory a Boulder.

- **Strumentazione**

  Sono previste la manutenzione del telescopio e la messa in esercizio di piccole migliorie.

- **Infrastruttura**

  Lavori di aggiornamento del sistema elettrico, come richiesto dalla peritia della SES.

  Riorganizzazione dei posti di lavoro.

6 ATTIVITÀ DIVULGATIVA

6.1 Visite guidate

20.2 Giovanna Rima-Pini, Associazione Quartiere Rivapiana, 10 persone

12.4 9 allievi del lavoro di maturità in astronomia del Liceo di Bellinzona

2.5 Circa 20 allievi: giornate autogestite del Liceo di Locarno

23.5 Corrado Ribero, liceo scientifico di Novara, 20 persone

13.6 Beatrice Rima

13.8 Corrado Pidò, Rosario Mosello,

6.2 Stages informativi

23.5 Vivian Ostini, stage scuola media

28.6 Nico Malingamba, liceo di Bellinzona (per lavoro di maturità)

6.7 Betim Gashi, liceo di Bellinzona (per lavoro di maturità)

28-29.7 Alex Borgesi, liceo di Bellinzona (per lavoro di maturità)

8-19.8 Giulio Minore, stage

22.8 Stefano Della Rosa, stage

4.11 Mattia Pellegrini, stage

6.3 Organizzazione di eventi

Il lavoro di divulgazione è coordinato con la Specola Solare Ticinese e fa capo ad un gruppo di animatori composto dal personale scientifico di IRSOL e Specola, nonché da collaboratori volontari. Ci si presenta al pubblico sotto il nome di Centro Astronomico del Locarnese (CAL). Sono stati organizzati 20 eventi alla Specola Solare Ticinese.

Visite a carattere divulgativo sono organizzate all'IRSOL solamente su esplicita domanda. Una lista di eventi é riassunta al punto 6.1.

6.4 Partecipazione ad eventi e conferenze divulgative

12-15.1 Al Centro sportivo nazionale di Tenero è stata organizzata la manifestazione divulgativa "Sportech 2016". L'IRSOL e la Specola Solare Ticinese sono stati invitati a presentare il loro lavoro. I collaboratori dei due istituti hanno svolto delle presentazioni intitolate "Il Sole, la sua luce, i tuoi occhi" a 18 classi proveninenti da diverse Scuole Medie e Medie-Superirori. La Società svizzera di Astrofisica e Astronomia ha fornito un contributo finanziario per l'acquisto del materiale didattico utilizzato in quell'occasione.

11.11 R. Ramelli e F. Calvo hanno partecipato all'evento "Techday" al Liceo di Bellinzona. Ciascuno ha presentato un modulo che descrive l'attività di ricerca sul Sole a 3 gruppi di studenti.

18.5 M. Bianda, "La ricerca solare: aspetti della ricerca in fisica solare", Osservatorio Galileo, Suno

6.5 Lavori di Maturità seguiti all'IRSOL

Alex Borgesi: "L'applicazione dell'effetto Doppler per ottenere la velocità radiale di una stella" (docente responsabile: R. Ramelli, liceo Bellinzona)

Danilo Consolascio: "Vita morte e miracoli delle stelle" (docente responsabile: G. Boffa, liceo Locarno)

Betim Gashi: "Determinazione della velocità radiale delle stelle tramite effetto Doppler" (docente responsabile: R. Ramelli, liceo Bellinzona)

Andrea Losa: "Polarizzazione dela luce" (docente responsabile: G. Boffa, liceo Locarno)

Mihaela Krsteva: "Misura della rotazione del Sole" (docente responsabile: R. Ramelli, liceo Bellinzona)

Nico Malingamba: "Determinazione della temperatura di una macchia solare" (docente responsabile: R. Ramelli, liceo Bellinzona)

Stefan Oljaca: "Velocità orbitale di Venere determinata con l'effetto Doppler" (docente responsabile: G. Boffa, liceo Locarno)

Karola Talamona: "Studio spettropolarimetrico del magnetismo solare" (docente responsabile: M. Gatto, Istituto Statale Istruzione Superiore Valceresio, Bisuschio, I)

6.6 Presenza nei media

6.6.1 Televisione

12.2 Servizio sulla RTSI nella trasmissione "Il Quotidiano"
(http://www.irsol.ch/i/servizio-sullirsol-alla-rsi-nella-trasmissione-il-quotidiano/)

6.6.2 Articoli apparsi sulla stampa

- "Associato all'USI l'Istituto Ricerche Solari Locarno" SQUARE USI-Magazine, 19, 2016

7 ATTIVITÀ SCIENTIFICA

7.1 Visite

4-7.3 Alexander Kosovichev, Irina Kitiashvili, New Jersey Institute of Technology, USA

16.3 Hans Dieter Bauer, Hochschule RheinMain, Germany

12-15.4 Nadia Kostogryz, Kiepenheuer Institut für Sonnenphysik, Germany

8-18.7 Eberhard Wiehr, Göttingen, Germany

27-29.7 Bruce Lites, USA/Costa Rica

4.9-3.10 K. Nagendra, M. Sampoorna, Indian Institute for Astrophysics, Bangalore, India

17-19.9 David Harrington, Stacey Svedoca, Natinal Solar Observatory, USA

3-6.12 S.P. Rajaguru, Indian Institute for Astrophysics, Bangalore, India

16.12 Igor Stefanini, SUPSI, Switzerland

7.2 Visite ad altri istituti

17.4-2.5 F. Calvo, Instituto de Astrofísica de Canarias, Tenerife

10-25.5 E. Carlin, Instituto de Astrofísica de Canarias, Tenerife

3.6 M. Bianda, S. Cortesi, R. Ramelli, Biblioteca del Politecnico, Zurigo

19-31.12 E. Carlin, Instituto de Astrofísica de Canarias, Tenerife

7.3 Partecipazione a congressi, assemblee e corsi

28.1 R. Ramelli, "GCOS Rundtisch", presentation, Meteoswiss, Zurich Airport

1-3.3 J.O. Stenflo, participation in ISSI/VarSITI Forum on "Future evolution of solar activity at ISSI", Bern

11-13.4 F. Calvo, G. Janett, O. Steiner [11-13.4] oral presentations at the Third CO5BOLD Workshop at INAF/Osservatorio Astronomico di Capodimonte, Napoli (IT)

31.5 , 3.6 J.O. Stenflo, participation in the 47th Meeting of the Solar Physics Division of the American Astronomical Society in Boulder, Colorado, May 31 - June 3, 2016.

4.6 J.O. Stenflo, participation in the "DKIST Critical Science Plan Development Workshop 1" at the National Solar Observatory in Boulder, Colorado

6-10.6 F. Calvo, O. Steiner, poster presentation at Cool Stars 19 in Uppsala (SW);

8-10.6 G. Janett, Poster presentation at the Platform for Advanced Scientific Computing Conference, PASC16, Lausanne (CH);

9-12.8 O. Steiner, invited talk at the conference Solar and Stellar Magnetic Fields in Goslar (DE);

12-16.9 L Belluzzi, M. Bianda, F. Calvo, E. Carlin, G. Janett, K.N. Nagendra, R. Ramelli, O. Steiner, J.O. Stenflo, several oral presentations at "Solar Polarization Workshop N. 8", Firenze

4-5.10 L Belluzzi, M. Bianda, F. Calvo, G. Janett, R. Ramelli, O. Steiner, several oral presentations at "1st Swiss SCOSTEP workshop", Uni Bern

6-7.10 F. Calvo, G. Janett, General Assembly of the Swiss Society for Astrophysics and Astronomy in Davos (CH);

18-20.10 F. Calvo, Parallel Programming Workshop (MPI, OpenMP and Advanced Topics) HLRS supercomputing center Stuttgart (DE)

8-9.12 M. Bianda, D. Gisler, "GREGOR Meeting", MPS, Göttingen

7.4 Colloqui all'IRSOL

4.3 Irina Kitiashvili, NASA Ames Research Center, NASA Advanced Supercomputing, presentazione al Centro Svizzero di Calcolo Scientifico, CSCS, "Numerical Simulations of Solar and Stellar Turbulent Dynamics", in occasione di una visita all'IRSOL e alla Specola Solare Ticinese

29.7 Bruce Lites, Senior Scientist in the High Altitude Observatory of the National Center for Atmospheric Research, "Are internetwork magnetic fields in the solar photosphere horizontal or vertical?"

26.10 Souvik Bose, Indian Institute of Astrophysics, Bangalore, "High Precision Full Stokes Spectropolarimetry of the Sun as a star-Instrument design aspects"

18.9 David Harrington, National Solar Observatory, Boulder, US, "The Daniel K. Inouye Solar Telescope, polarization calibration"

5.12 S.P. Rajaguru, Indian Institute of Astrophysics, Bangalore, "Small- and large-scale flows on the Sun: surface and helioseismic measurements, and implications for dynamo mechanisms"

7.5 Campagne osservative

8-20.10 Belluzzi, Bianda, Carlin, Gisler at Tenerife, Spagna, telescopio GREGOR

7.6 Collegio di esame

12.07 Daniel Gisler membro del collegio degli esaminatori per il Master di Mathis Engelhard presso il dipartimento di Fisica applicata della Hochschule RheinMain.

11.11 Michele Bianda membro del collegio degli esaminatori per la difesa di dottorato di Giovanni Privitera presso l'Observatoire de Genève, Università di Ginevra.

7.7 Comitato scientifico consultivo

23-24.6 Riunione all'IRSOL per dare una consulenza scientifica all'istituto. I risultati sono riportati nel documento: "Report of the Science Advisory Committee of IRSOL".

8 PUBBLICAZIONI

apparse

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8.1 Altre pubblicazioni

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