Solarnet III/HELAS VII/SpaceInn Conference

The Sun, the stars, and solar-stellar relations

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Contents

Conference Programme

Sunday - August 30, 2015

17:00 – 20:00 Lobby Registration

18:30 Lobby City Tour

19:30 Lobby Self-paid dinner at a nearby restaurant

Monday - August 31, 2015

08:00 Foyer Registration (whole week)

08:30 Lobby Welcome Coffee

9:30 – 12:20 Room "Colmar"

Splinter I: Comparing and Validating Meridional Flow Derivations in the Solar Convection Zone

09:25 – 12:30 Conference Room "Basel"

Splinter II: Waves inside Stars: Theory, Simulations, Observational Signatures, and Lab Experiments

10:30 – 11:00 Coffee Break & Posters

12:30 – 14:00 Lunch at Restaurant La Rotonde

Session I: Solar and Stellar Observations ***Chair: Frank Hill***
Conference Room "Basel"

14:00 Markus Roth
Welcome

14:10 Lucia Kleint
Invited Talk: An Overview of Polarimetry

14:40 Roman Brajsa
Modeling Radiation from the Solar Atmosphere in the sub-mm, mm and cm Wavelength Range

15:00 Christopher J. Nelson
On The Relationship Between Ellerman Bombs and Other Solar Processes

15:20 Jan Langfellner
Anisotropy of the solar network magnetic field around the average supergranule

15:40 Manfred Schüssler
The cause of the weak solar cycle 24

16:00 – 16:30 Coffee Break & Posters

16:30 Ralph Neuhäuser
Strong variations of 14-C around AD 775 and AD 1795 - due to solar activity

16:50 Rob Rutten
A new view of the Halpha chromosphere

17:10 Sanjay Gosain
Full Stokes Polarimeter for Chromospheric Measurements with SOLIS/VSM

17:30 Junwei Zhao
Establishing Connections between Photospheric Waves and Coronal Waves in Active Regions

17:50 Sanjay Gosain
A Proposal for Next Generation Synoptic Solar Instrumentation

18:10 Frank Hill
GONG Status

Tuesday - September 1, 2015

08:30 Lobby Welcome Coffee

Session II: Solar and Stellar Modelling ***Chair: Rudolf Komm***
Conference Room "Basel"

09:00 Matt Browning
Invited Talk: Global Simulations of solar and stellar dynamos: cycles, theories, and limits

09:30 Manfred Schüssler
The Babcock-Leighton solar dynamo

09:50 Jacobo Varela
Differential Rotation and Dynamo Action in Solar-like Stars

10:10 Zarzalt Magic
Inivted Talk: 3D MHD Stellar Atmosphere Simulations

10:40 – 11:10 Coffee Break & Posters

11:10 Laurene Jouve
Invited Talk: Models and data combined to progress towards a better understanding of the magnetism of solar-type stars

11:40 Volkmar Holzwarth
Joint magnetospheres of close "solar-twin" binary systems

12:00 Aditi Sood
Dynamical model for spindown of solar-type stars

12:20 Conference Photo

12:30 – 14:00 Lunch at Restaurant La Rotonde

Session III: Solar and Stellar Seismology ***Chair: John Leibacher***
Conference Room "Basel"

14:00 Ariane Schad
Invited Talk: Global helioseismic measurement of meridional circulation and differential rotation from mode eigenfunction perturbations

14:30 S.P. Rajaguru
Deep structure of solar meridional circulation: helioseismic inferences from four years of HMI/SDO observations

14:50 Ruizhu Chen
Measurement of deep solar meridional flow and its temporal variation

15:10 Dean-Yi Chou
Solar-Cycle Variations of Meridional Flows and Magnetic Signature at the Base of Convection Zone

15:30 Rosaria Simoniello
Helioseismic Signatures of the Progression of Solar Cycle: A Reflection of a Dynamo Wave

15:50 – 16:20 Coffee Break & Posters

16:20 Charles S. Baldner
Variations in Large-scale Flow Structures in the Current Solar Cycle

16:40 Rudolf Komm
Large-scale subsurface flows during Solar Cycle 23 and 24

17:00 Anne-Marie Broomhall
Statistical searches for low signal-to-noise oscillations

17:20 Kaori Nagashima
Measurement of the amplitude of the solar cross-covariance function

17:40 Vincent Böning
Validating Spherical Born Kernels for Meridional Flows

18:00 Björn Löptien
Data Compression for Helioseismology

Wednesday - September 2, 2015

08:30 Lobby Welcome Coffee

Session III: Solar and Stellar Seismology (continued) ***Chair: Rekha Jain***
Conference Room "Basel"

09:00 Damien Przybylski
Signatures of mode conversion in a sunspot simulation

09:20 Khalil Daiffallah
Helioseismology of sunspot models

09:40 Rudolf Komm
Subsurface helicity of active regions 12192 and 10486

10:00 Johannes Löhner-Böttcher
Magnetic field reconstruction based on sunspot oscillations

10:20 – 10:50 Coffee Break & Posters

10:50 Ângela Santos
Contribution from sunspots to the observed frequency shifts

11:10 Kiran Jain
Response of Solar Oscillations to The Magnetic Activity: Comparison between Solar Cycles 23 and 24

11:30 Jesper Schou
What to do Next in Global Mode Seismology?

11:50 Foyer Packed Lunch

Excursion to Europa-Park Rust & Conference Dinner

12:45 Buses leave to Rust

13:30 Entry into Europa-Park Rust
via the entrance of the Hotel El Andaluz

20:00 – 23:00 Conference Dinner
at the Hotel Santa Isabella, Room: Convento

23:00 Buses return to Freiburg

Thursday - September 3, 2015

08:30 Lobby Welcome Coffee

Session III: Solar and Stellar Seismology (continued) ***Chair: Conny Aerts***
Conference Room "Basel"

09:00 Sarbani Basu
Invited Talk: Seismic inferences of solar and stellar structure

09:30 George Angelou
On the Utility of Diagrams of Small Frequency vs Large Frequency Separation

09:50 Elisabeth Guggenberger
Towards an improvement of the scaling relations

10:10 Mutlu Yildiz
Effects of the HeII ionization zones on oscillation frequencies and their promises

10:30 – 11:00 Coffee Break & Posters

11:00 Maria Bergemann
Invited Talk: Chemical abundances of the Sun and solar-like stars

11:30 Vincent Ballenegger
Thermodynamic properties of hydrogen and hydrogen-helium mixtures under solar conditions

11:50 Antonio Ferriz-Mas
Chandrasekhar's 'adiabatic exponents' and other material coefficients for stellar interiors

12:10 Ehsan Moravveji
Tight asteroseismic constraints on core overshooting and diffusive mixing for massive stars

12:30 Gaël Buldgen
Constraining mixing processes in 16CygA and 16CygB using Kepler data and seismic inversion

12:50 – 14:15 Lunch at Restaurant La Rotonde

Session IV: In Memory of Jean-Paul Zahn **Chair: Eric Michel**
Conference Room "Basel"

14:15 Stephane Mathis / Ian Roxburgh
Invited Talk: A Tribute to Jean-Paul Zahn

14:45 Sebastien Deheuvels
Invited Talk: What asteroseismology is teaching us about the internal rotation of stars

15:15 Santiago Andres Triana
The internal rotation of stars as revealed by asteroseismic inversions

15:35 Coffee Break & Posters

16:15 Vincent Prat
Ray dynamics of gravito-inertial modes in rapidly rotating stars

16:35 Paul G. Beck
Seismic analysis of red giant stars in binary systems –
the heartbeat of red giants

16:55 Wiebke Herzberg
The effect of large scale flows on the eigenfrequencies of subgiant stars

17:15 Guy Davis
Invited Talk: Sounding solar and stellar activity cycles using asteroseismology

Friday - September 4, 2015

08:30 Lobby Welcome Coffee

Session V: Solar and Stellar Activity **Chair: Guy Davis**
Conference Room "Basel"

09:00 Thomas Ayres
Invited Talk: The Ups and Downs of Stellar Activity

09:30 Svetlana Berdyugina
Invited Talk: Overview on sunspots and starspots

10:00 Lousie Harra
Invited Talk: Review of solar flares

10:30 – 11:00 Coffee Break & Posters

11:00 Manfred Kitze
Superflares on solar analogue stars

11:20 Rekha Jain
Oscillations in a solar coronal arcade near a flare-site

11:40 Alina Donea
Invited Talk: Seismicity induced by solar and stellar flares: comparison

12:10 Frederic Baudin
Flares and solar p-modes

12:30 Goodbye

12:30 – 14:00 Lunch at Restaurant La Rotonde

14:00 Conference Room "Basel" left

Splinter III: Open-access tools for local helioseismology provided by SpaceInn

14:00 Conference Room "Basel" right

Splinter IV: Meridional flow, α effect, single vs multiple dynamo: addressing open issues in solar/stellar dynamo with p-mode parameters

15:30 – 16:00 Coffee Break

17:00 End

Splinter Sessions

Splinter I: Comparing and Validating Meridional Flow Derivations in the Solar Convection Zone

Organisers:

Junwei Zhao (Stanford University)
Markus Roth (Kiepenheuer-Institut für Sonnenphysik)

Abstract:

Solar interior rotation and meridional flow are global-scale flows that control magnetic field generation, amplification, and transport inside the Sun. While the interior rotation profiles have long been solved through the global helioseismology method, a precise determination of the meridional flow in the deep solar interior only witnessed significant progresses recently. After removing a systematic center-to-limb effect through an empirical method, Zhao et al. (2013, ApJ Lett, 774, L29) detected a shallower-than-expected equatorward flow and found evidences of a double-cell circulation using time-distance helioseismology. At about the same time, by use of a newly developed method based on global modes, Schad et al. (2013, ApJ Lett, 778, L38) found multi-cell circulation structures in both radial and latitudinal directions. Despite these advances, substantial differences remain in results obtained from these two abovementioned methods. It is important as well as necessary for the HELAS VII workshop participants, who are interested in meridional-flow studies, to hold a splinter session with a hope to further compare and validate their research methods.

The following topics will be discussed in the splinter session:

1. Compare results obtained from recent analyses using time-distance and global-mode methods. Identify similarities and differences in these results, and discuss what can be done to resolve these differences.

2. Some numerical simulation data, including single-cell, double-cell, and multi-cell models, will be made available to the participants and maybe the wider community for the purpose of validating different methods. For each set of simulation, the original simulation data and the data after an artificial center-to-limb effect is added will be provided, so that the effectiveness of the center-to-limb effect-removal method will also be evaluated.

3. All current inversions using time-distance measured travel-time shifts employ ray-approximation kernels, and a more complicated Born-approximation kernel is expected to offer more robust inversion results. The splinter session will discuss the current status and availability of Born approximation kernels, and explore the possibility of incorporating these kernels in the time-distance inversion processes.

Programme:

Monday August 31, 2015; Meeting Room “Colmar”

9:30-9:40	Ariane Schad: Updates on meridional-flow results using global modes
9:40-9:50	Ruizhu Chen: Updates on time-distance meridional flow results
9:50-10:00	Paul Rajaguru: Recent results on meridional flow using time-distance analysis
10:00-10:20	Discussion: Comparison of results from different methods and how to further compare results from different groups
10:20-10:30	Junwei Zhao: Global-scale simulation to validate meridional-flow analysis
10:30-10:45	Discussion: How to use the simulation data to validate different analysis methods, and what more are needed from simulations
10:45-11:05	Coffee
11:05-11:15	Jesper Schou: The nature of the center-to-limb effect
11:15-11:30	Discussion: Is there a better way to remove the center-to-limb effect?
11:30-11:40	Dean-Yi Chou: Surface magnetic effects on meridional flow measurements
11:40-11:55	Discussion: What is the best strategy to remove the magnetic effect from local- and global-helioseismology method?
11:55-12:05	Vincent Böning: Born- versus ray-approximation kernels for the meridional flow
12:05-12:20	Discussion: What are advantages for each kernel, and how we can incorporate the Born-kernel in the inversion?

Splinter Session II: Waves inside Stars: Theory, Simulations, Observational Signatures, and Lab Experiments

Organisers:

Tamara Rogers (Newcastle University, UK)
Conny Aerts (Leuven University, B)

Abstract:

Waves are as ubiquitous in stars as they are on Earth. Just as on Earth, waves can transport angular momentum and mix species within stellar interiors, steering their rotational and chemical evolution. Waves also set up standing modes which can be observed through helio- and asteroseismology. Helioseismology has revolutionized our picture of the Sun, constraining the internal rotation profile and convective undershooting in the solar interior. Asteroseismology is not far behind, recently constraining core-envelope differential rotation and core convective overshooting in more massive stars. Indeed, the observations of waves through helio- and asteroseismology places the tightest constraints on the dynamical evolution those same waves induce.

This 3-hour splinter session aims to bring together researchers doing theory, simulations, and observations of waves in stars (gravity, pressure and mixed) with the hope that the synergy between the three (often disparate) fields could lead to tests and comparisons which would further our understanding of stellar interiors. Moreover, we include also studies of wave generation by convection in laboratory experiments to search for connections between those and stellar physics. We begin this session with four short talks on each of the sub-topics and will then continue with a guided discussion on how these fields can work together to advance our understanding.

Programme:

Monday 31 August, 09:25 - 12:30; Conference Room "Basel"

09:25 Welcome

09:30 - 10:00 Theory: Stephane Mathis (Saclay, France)

10:00 - 10:30 Simulations: Tami Rogers (Newcastle, UK)

10:30 - 11:00 Coffee Break

11:00 - 11:15 Observational Signatures: Conny Aerts (Leuven, B)

11:15 - 11:30 Lab Experiments: Santiago Andres Triana (Leuven, B)

11:30 - 12:15 Guided discussion, participants are encouraged to bring 1 slide

12:15 - 12:30 Summary of Synergies & Future Steps

Splinter Session III: Open-access tools for local helioseismology provided by SpaceInn

Organisers:

Vigeesh Gangadharan (Kiepenheuer-Institut, Freiburg)
Kaori Nagashima (Max-Planck-Institut für Sonnensystemforschung)
Markus Roth (Kiepenheuer-Institut, Freiburg)

Abstract:

The SpaceInn project plans to provide archival data and analyses tools for local helioseismology. A collection of data sets is already available through the project for carrying out various helioseismic studies. Providing such a standard data set also allows comparison between different techniques used in local helioseismology. Additionally, a basic set of tools to handle the data is also being made available for researchers and novices in the field. The project ultimately aims to build a comprehensive and easily accessible toolkit that will enable the community to fully exploit the data provided by space- and ground-based observations.

In this splinter session, we will introduce a few tools that are currently available through SpaceInn. We also plan to discuss on the development of these tools in an open-source/access framework and in a more collaborative environment that will allow us to set benchmarks for comparison and reproducibility of results. This is also intended to serve as a platform to bring together researchers willing to share/contribute their expertise/tools and those who want to explore the data for their specific studies.

Programme:

Friday, Sep 4, 2015; Conference Room "Basel" left

14:00 - 14:20 Introduction to tools on the SPACEINN WP4 - Kaori Nagashima

14:20 - 15:00 Fourier-Hankel/Legendre pipeline - Vigeesh Gangadharan

Fourier-Hankel/Legendre analysis is one of the helioseismic techniques employed to infer the internal properties of the Sun. It has been successfully applied to study p-mode interaction with sunspots and to measure sub-surface meridional flow. As part of SpaceInn project, we have implemented a new Fourier-Hankel/Legendre analysis module on the SDO/HMI JSOC data-analysis pipeline. We will present the details of the module and some preliminary results. We will also discuss on its applicability to meridional flow, differential rotation measurements and active region seismology.

15:00 - 15:30 Discussion

15:30 - 16:00 Coffee Break

16:00 - 17:30 Discussion (Contd.)

The main goal of the discussion session will be:

i) To review the collection of dataset and tools provided by the SpaceInn project available at: http://www2.mps.mpg.de/projects/seismo/SpaceInn/index.html

To get feedback on issues and suggestions for improvement of these dataset and tools. To compile a list of requested updates and additional tools (for e.g. mode fitting and inversion routines) for future use. To discuss updates to the information collected on systematic effects (approx. 30 min).

ii) To provide an overview on how these tools can be used for local helioseismology. To identify other science goals and to obtain relevant resources (codes from other researchers) needed to address them and to provide them as part of the project. To discuss on copyright and other issues of providing these resources in an open-access/source platform (approx. 30 min).

iii) To plan on migrating to a public repository (for e.g. git) in order to maintain all the current and planned codes and their future updates. To discuss on developing these tools into a more comprehensive toolkit (approx. 30 min).

Those interested in attending this splinter session may contact:

Kaori Nagashima (nagashima@mps.mpg.de) or

Vigeesh Gangadharan (vigeesh@kis.uni-freiburg.de).

Splinter IV: Meridional flow, α effect, single vs multiple dynamo: addressing open issues in solar/stellar dynamo with p-mode parameters

Organiser:

Rosaria Simoniello (Geneva Observatory, CH)

Abstract:

The onset of solar cycle at mid-latitudes, the slow down of the sunspot drift toward the equator and the overlap of successive cycles at the time of activity minimum are delicate issues in αΩ and flux transport dynamo models. Very different parameter values produce similar results, making difficult the goal of achieving a unified dynamo model. To overcome this limit the role of α effect with respect to meridional flows has to be clarified. Within this context, helioseismology may play a key role. In fact, flux transport dynamo models also predict a slowing down of the sunspots towards the equator (Hathaway et al. 2003) and the beginning of a new cycle at higher latitudes before sunspot eruptions of the old cycle terminates at low latitudes. This leads to a tail-like attachment in the butterfly diagram (Nandy et al. 2002, Chatterjee et al. 2004). The classical description of α dynamo wave does predict the slow down of sunspot velocity drift as well as overlapping cycle (Schüssler et al. 2004), whose properties are different from the ones predicted by flux transport dynamo model.

Low and high degree acoustic p-mode parameters are the perfect diagnostic tool to infer these specific properties. Therefore it is important as well as necessary for the HELAS VII workshop participants, who are involved in low and high degree p-mode parameter analysis, to hold a splinter session with the aim to identify the open issues in solar dynamo which can be naturally addressed by looking at mode frequencies, widths and amplitudes.

Programme:

Friday, September 4, 2015; Conference Room “Basel” right

The following topics will be covered in the splinter session:

• 14.00-14.45 The progression of solar cycle as seen in low and high degree modes

How does it evolve the solar cycle at different latitudes? Are there any differences in the progression of solar cycle in the individual component of low degree modes (ℓ=0,1,2)? If yes what do they tell us? How do they agree or not with the analysis of intermediate/high degree modes?

• 14.45-15.30: On the origin of multiple magnetic cycles

Single dynamo or multiple dynamos: are the 11 and 2 yr cycle signatures of two distinct dynamos operating in the Sun (Benevolenskaja et al. 1998) or instead just only an amplitude modulation of the dipolar/quadrupolar component (Tobias et al. 1997)?

• 16.00-16.45: The cycle length variations

There are significant variations over the 11 and 2 year cycle length. This is an important diagnostic tool for dynamo probe. How does it change the length of the 11 yr with respect to the 2 year cycle length (Charboennau et al. 2015, in preparation)?

• 16.45-17.30 Frequency shift as activity proxy over the different phases of solar cycle

Minimum/Maximum: are the two phases where the correlation with activity proxies gets worse. Why is that? Is another mechanism contributing to solar dynamo? Local dynamo or what else?

• 17.30-18.00: Summary and Conclusions

This splinter session is seen as an opportunity to exchange ideas and discuss how to further collaborate on the above-mentioned topics. In this 3-hour session, we expect presentations on voluntary bases from anyone willing to shows 1-2 plots, figures which will stimulate discussions and will foster collaborations within the helioseismic community dealing with low and high degree modes.

Anyone willing to participate and/or present their plots/figures needs just to send an e-mail at
rosaria.simoniello@unige.ch
in order to organize the session.

Talks

Monday, August 31, 2015

Session I: *Solar and Stellar Observations*

14:10 – 14:40

Lucia Kleint: An Overview of Polarimetry

Polarimetry is one of the important diagnostics of solar and stellar physics. The most prominent polarization is seen in sunspots via the Zeeman effect, and allows us to determine their magnetic field, both on the Sun and on other stars. Scattering processes also polarize light, and this polarization may be modified through the so-called Hanle effect in the presence of even unresolved magnetic fields. I will review the different principles to measure polarization and illustrate them with measurements spanning from the quiet Sun to starspots.

14:40 – 15:00

Roman Brajsa: Modeling Radiation from the Solar Atmosphere in the sub-mm, mm and cm Wavelength Range

Authors: Roman Brajsa, Matej Kuhar, Arnold O. Benz, Ivica Skokic, Davor Sudar, Miroslav Barta, Sven Wedemeyer, Tim Bastian, Hugh Hudson, Stephen White, Masumi Shimojo, Antonio Hales, Anthony Remijan

Maps of the Sun in millimeter wavelength range reveal emission features (high temperature regions, HTR) and absorptive features (low temperature regions, LTR). Thermal bremsstrahlung and gyromagnetic (cyclotron) radiation mechanism can be important for explaining the observed phenomena. We use a procedure for calculating the brightness temperature for a given wavelength and model atmosphere, which integrates the radiative transfer equation for thermal bremsstrahlung. The aim of the present work is to apply the models for different structures of the solar atmosphere on a broad wavelength range (from 0.3 mm to 1 cm), closely related to that of Atacama Large Millimeter/submillimeter Array (ALMA), and to compare the results with available observations. We conclude that thermal bremsstrahlung is the dominant radiation mechanism in the submillimeter and millimeter wavelength range, which can explain previous observations. In the near future, we will be able to compare the results of our models to new observations of ALMA telescope. We also introduce the activities of the Solar Simulations for the Atacama Large Millimeter Observatory Network (SSALMON; http://www.ssalmon.uio.no), organized for the promotion of the scientific potential of solar ALMA observations.

15:00 – 15:20

C. J. Nelson: On The Relationship Between Ellerman Bombs and Other Solar Processes

Authors: C. J. Nelson, J. G. Doyle, R. Erdelyi

Ellerman Bombs are often observed as brightenings in the wings of photospheric absorption lines such as H-alpha within active regions. These features are small-scale, with cross-sectional diameters often below 1 Mm, and short-lived, usually appearing and disappearing within approximately 10 minutes. The links between Ellerman Bombs and regions of strong photospheric line-of-sight magnetic fields, including Moving Magnetic Features (MMFs), have been well documented in the literature and have led some authors to suggest that magnetic reconnection could be their driver. In this talk, we present high-resolution ground-based observations of the solar atmosphere, supplemented by SDO/HMI photospheric magnetograms, to further understand the link between Ellerman Bombs and MMFs. Cancellation rates of identified MMFs are incorporated into a well-used analytical model of photospheric magnetic reconnection in order to estimate observable parameters, such as up-ward flow velocities, and further interesting properties, such as the potential up-ward mass flux from these events. This work aims to understand the sporadic relationship between Ellerman Bombs and ejection events from the photosphere (for example, surges).

15:20 – 15:40

Jan Langfellner: Anisotropy of the solar network magnetic field around the average supergranule

Authors: Jan Langfellner, Laurent Gizon, Aaron Birch

Solar supergranules are surrounded by magnetic fields that form a web-like structure, the so-called network field. We investigate the magnetic field around the average supergranule near disk center using SDO/HMI observations. The average supergranule is constructed by identifying the locations of 3000 supergranules in maps of the horizontal flow divergence (obtained with time-distance helioseismology) and co-aligning the identified supergranules. We find that the magnetic field around the average supergranule, as measured from HMI magnetograms, is stronger in the west (prograde direction) than in the east. Such an anisotropy is also measured with mean travel times, which are sensitive to magnetic field. In addition, we present maps of the spatially resolved vertical velocity component (measured from Dopplergrams at disk center) at the average supergranule. A comparison of SDO/HMI and SOHO/MDI shows a difference in the upflow magnitude (22 m/s vs. 15 m/s) at the center of the outflow.

In the surrounding ring of inflows, the associated downflows show an east-west anisotropy (both for HMI and MDI), which is possibly linked to the magnetic field anisotropy.

15:40 – 16:00

Manfred Schüssler: The cause of the weak solar cycle 24

Authors: J. Jiang, R.H. Cameron, M. Schüssler

The ongoing 11-year cycle of solar activity is considerably less vigorous than the three cycles before. It was preceded by a very deep activity minimum with a low polar magnetic flux, the source of the toroidal field responsible for solar magnetic activity in the subsequent cycle. Simulation of the evolution of the solar surface field shows that the weak polar fields and thus the weakness of the present cycle 24 are mainly caused by a number of bigger bipolar regions with a 'wrong' (i.e., opposite to the majority for this cycle) orientation of their magnetic polarities in the North-South direction, which impaired the growth of the polar field. These regions had a particularly strong effect since they emerged within ±10° latitude from the solar equator. [Astrophys. J. 808, L28; 2015]

16:30 – 16:50

Ralph Neuhäuser: Strong variations of 14-C around AD 775 and AD 1795 **-** due to solar activity

Authors: Ralph and Dagmar Neuhäuser (AIU U Jena)

The strong 14-C increase in data with 1-yr time resolution in the AD 770s (e.g. Miyake et al. 2012) is still a matter of debate, e.g. a solar super-flare. In the last three millennia, there were two more strong rapid rises in 14-C - around BC 671 and AD 1795. All three 14-C variations are embedded in similar evolution of solar activity, as we can show with various solar activity proxies; secular evolution of solar wind plays an important role. The rises of 14-C - within a few years each - can be explained by a sudden strong decrease in solar modulation potential leading to increased radioisotope production.
The strong rises around AD 775 and 1795 are due to three effects:
(i) very strong activity in the previous cycles (i.e. very low 14-C level),
(ii) the declining phase of a very strong Schwabe cycle, and
(iii) a phase of very weak activity after the strong 14-C rise - very short and/or weak cycle(s) like the suddenly starting Dalton minimum.

For the AD 770s, we critically review all known oriental and occidental aurora reports from AD 731 to 825 and find 39 likely true aurorae.
There were two aurorae in the early 770s observed near Amida (now Diyarbakir in Turkey near the Turkish-Syrian border); they indicate a relatively strong solar storm. However, it cannot be argued that those aurorae (geo-magnetic latitude 43 to 50 degrees) could be connected to solar super-flares causing the 14-C:
There are several reports about low- to mid-latitude aurorae at 32 to 44 degrees in the 760s and 790s in China and Iraq - always without 14-C peaks.
We can reconstruct the Schwabe cycles around AD 774/5 with 14-C and aurorae, then we can show that AD 775 lies in the declining phase of a previously strong Schwabe cycle.

We also discuss the frequency of super-flare on sun-like stars and compare it with the Sun.

16:50 – 17:10

Rob Rutten: A new view of the Halpha chromosphere

Lockyer's original name "chromosphere" for what he saw spectroscopically off the limb implies that the chromosphere on the disk is largely made by the thick carpet of fibrils one observes in Balmer-alpha. There are various types of fibrils and various ideas about their nature. I will explain and illustrate a new interpretation and speculate how the different types originate.

17:10 – 17:30

Sanjay Gosain: Full Stokes Polarimeter for Chromospheric Measurements with SOLIS/VSM

Authors: Sanjay Gosain and Jack Harvey

SOLIS stands for Synoptic Optical Long-term Investigations of the Sun. Daily fulldisk magnetic fields measurements of the Sun are being done for several decades at NSO Kittpeak. The SOLIS/VSM instrument replaced earlier instruments at Kitt Peak. The current SOLIS/VSM instrument has capability to make full Stokes polarimetry in photospheric lines, however, for chromosphere only longitudinal polarimetry exists. With the recent progress in non-LTE inversions of the chromospheric spectra it was decided that a full Stokes polarimeter needs to be developed. Based on similar design to photospheric modulator we have developed a separate modulator for chromospheric full Stokes measurements using Ca II 854.2 nm line. We will present design and performance of the new modulator and possibly sample observations.

17:30 – 17:50

Junwei Zhao: Establishing Connections between Photospheric Waves and Coronal Waves in Active Regions

Authors: Junwei Zhao & Ruizhu Chen

Recently, through cross-correlating oscillation signals observed by SDO/HMI in sunspots' umbrae with signals observed in penumbrae and the sunspots' vicinity, we have identified a fast-moving wave from the inside to the outside of sunspots along the radial directions. The speed of wave is about 45 km/s, and can be explained as wavefronts, whose sources are located below the sunspots' surface, sweeping across the photosphere. In this work, we try to establish a connection between this photospheric wave with the penumbral running waves observed in the chromosphere, and the slow-mode wave observed near the footpoints of coronal loops. We use HMI observations for the photospheric waves, AIA 1600 Å and 1700 Å lines for the lower chromosphere, BBSO NST H-alpha lines for the chromosphere, and AIA 171 Å and 304 Å lines for the lower corona. Our analysis shows that the wave phenomena observed at different atmospheric heights using different spectrum lines are actually a same slow magnetoacoustic wave propagating upward, with a wave source likely located a few megameters beneath the sunspots' surface.

17:50 – 18:10

Sanjay Gosain: SPRING: A Proposal for Next Generation Synoptic Solar Instrumentation

Authors: Sanjay Gosain, Markus Roth, Frank Hill, Michael Thompson

Synoptic observations of the Sun are very important to understand the long term behavior of the solar activity cycle. Our current understanding solar magnetic cycle is rather in its infancy, as can be inferred from our very poor prediction for the strength of solar cycle 24, based on various dynamo models. Solar magnetism is at the heart of all solar activity and therefore it is important to understand what parameters govern the magnetic cycle in the Sun. An important parameter that is realized more recently is the internal dynamics, i.e., profile of solar internal rotation and nature of large scale meridional flows. Therefore, it is important to study the solar interior by making use of helioseismology. Ground based helioseismology networks such as GONG are now quite few decades old and its possible failure poses risk to the continuity of solar oscillation data. Hence, a next generation of synoptic network SPRING is being proposed and is currently under design study. We will present science requirements and the details of the SPRING network.

18:10 – 18:30

Frank Hill: GONG Status

GONG is now 20 years old, and continues to reliably provide data for the international helioseismology community. In addition, the role of GONG has expanded to provide data as input to a number of space weather forecasting systems. This talk will give a summary of the status of GONG, its future plans, and a brief review of some recent science results.

Tuesday, September 1, 2015

Session II: *Solar and Stellar Modelling*

9:00 – 9:30

Matt Browning: Global simulations of solar and stellar dynamos: cycles, theories, and limits

Magnetism is ubiquitous in stars, and in most cases this magnetism is thought to arise from convective dynamo action. But a comprehensive theoretical understanding of this process, and how it depends upon basic stellar parameters like mass and rotation rate, remains elusive. I will review some recent results from global-scale convective dynamo simulations that have begun to shed light on some aspects of the dynamo process, focusing in particular on what elements appear to play roles in establishing fields that are highly organised either in space or in time. I will discuss how these elements vary in different types of objects, and highlight some important differences between the Sun and other, lower-mass objects. I will also showcase some recent results that reveal new ways in which equatorward-propagating dynamo waves, akin in some ways to those we observe in the Sun, might be established. Finally, I will also describe some of the considerable uncertainties that persist in these simulations (and in our understanding of stellar dynamos generally), and speculate about how to do better.

9:30 – 9:50

M. Schüssler: The Babcock-Leighton solar dynamo

Authors: M. Schüssler and R.H. Cameron

Hale's polarity laws for sunspot groups, the helioseismic determination of differential rotation in the convection zone, and the success of surface flux transport models in reproducing the observed evolution of large-scale solar surface fields, together with a simple mathematical argument, yield compelling evidence that the large-scale solar dynamo operates according to the scenario originally envisaged by H.W. Babcock and R. Leighton in the 1960s. The polar fields represent THE poloidal flux from which the toroidal flux emerging in sunspot groups is wound up by (mainly latitudinal) differential rotation. The polar fields themselves result from tilted sunspot groups while small-scale magnetic features ("turbulence") do not provide a significant contribution.

9:50 – 10:10

Jacobo Varela: Differential Rotation and Dynamo Action in Solar-like Stars

Authors: J. Varela and S. A. Brun

The aim of the present study is to characterize the effect of the rotation rate in building magnetic field via dynamo action in solar-like stars. We use the code ASH to model the convective dynamo for solar-like stars at various rotation rates and hence Rossby numbers. We find that stable magnetic configuration without cycling evolution; with steady low latitude magnetic field wreaths are found for slowly rotating cases with large Rossby number. For models rotating faster with a low Rossby number, the convective dynamo shows a cycling activity, leading to systematic pole inversion. We also note that a topology change of the stellar magnetic field occurs going from a dipolar-like to a quadrupolar-like structure when the system magnetic energy drops during the cyclic activity, in good agreement with our star the Sun.

10:10 – 10:40

Zarzalt Magic: 3D MHD Stellar Atmosphere Simulations

Today's theoretical atmosphere models are very successful and enable astronomers to derive details of distant stars to a very high precision due to the development of 3D simulations and the rising computational power in the last decades. Large grids of 3D hydrodynamic stellar atmosphere with realistic radiative transfer have been computed, which will have various applications. In my contribution, I will give you an overview of the current state of stellar atmosphere models, and I will also discuss in detail the properties of the photospheric transition region. Furthermore, I will also report on our current efforts on understanding the complex interactions of the plasma and magnetic field in the atmosphere of the Sun.

11:10 – 11:40

Laurene Jouve: Models and data combined to progress towards a better understanding of the magnetism of solar-type stars

Authors: L. Jouve, C. Hung, A.S. Brun, A. Fournier, O. Talagrand

We will review recent progress made in modeling solar-type stars in 2D and 3D in the recent years. In particular, we will focus on advances in our understanding of the dynamo processes in such astrophysical objects and the necessary ingredients to reproduce what is found in the observations. We will also present recent attempts to introduce such observational data into multi-D MHD models. The idea is to implement data assimilation techniques to solar physics in order to have some tools to give tentative predictions of future solar activity.

11:40 – 12:00

Volkmar Holzwarth: Joint magnetospheres of close "solar-twin" binary systems

Close binary stars with late spectral-type components, such as RS CVn- or BY Dra-systems, are among the magnetically most active stellar objects known. The magnetic flux generated in the outer convection zone of these rapidly rotating cool stars leads after emergence at the stellar surface to a plethora of activity signatures, which cover large time-, spatial-, and spectral-ranges. Direct observations of coronal magnetic fields are, however, hardly possible and even in the case of the Sun limited to snapshots of localised regions. Investigations focusing on the structure and evolution of large-scale magnetic fields thus frequently apply approximation techniques which are based on the extrapolation of observed magnetic field distributions on the stellar surface into upper atmospheric layers.

Here, the potential field source surface approximation technique, which was originally developed for the case of the Sun and later applied to active single stars as well, has been extended to the case of binary systems to investigate their joint magnetospheres and, in particular, the properties of inter-connecting magnetic field structures. The extended modelling technique is described before its capabilities are demonstrated on the basis of a "solar-twin" system, for which synoptic magnetic maps of the Sun observed during different phases of its activity cycle are used. The connectivity of closed coronal loops, 'open' field regions, and inter-connecting field structures is determined for different combinations of solar synoptic maps (e.g. active-active, active-inactive) and compared with the joint magnetospheres of the system V4046Sgr.

12:00 – 12:20

Aditi Sood: Dynamical model for spindown of solar-type stars

We for the first time propose a spin-down model where the loss of angular momentum by magnetic fields is dynamically treated, instead of being kinematically prescribed. To this end, we evolve stellar rotation and magnetic field simultaneously over the stellar evolution time by incorporating the nonlinear feedback mechanisms on rotation and magnetic fields and examine the behaviour of rotation rate Ω with time t, magnetic field strength $|B|$ and frequency of magnetic field ω_{cyc} with rotation rate Ω.

Initially, rotation rate is found to decrease very rapidly with time until there is a sudden transition from fast to slow spin down of stars. The dependence of rotation rate on time illustrates exponential spin-down for rapid rotators and power law spin-down for slow rotators. For fast rotators, the strength $|B|$ is found to saturate for large Ω while for slow rotators, $|B|$ increases almost linearly with Ω. The analysis of the local frequency of magnetic fields reveals the existence of the two (active and inactive) branches of magnetic fields for stars with different frequencies ω_{cyc} which have different scalings with rotation rate Ω: the active and inactive branches with power law scaling exponents 0.85 and 1.16, respectively. The transition from fast to slow rotators occurs very rapidly with the disappearance of the active branch.

The Vaughan-Preston gap is consistently explained in our model by the shortest spin-down timescale in this transition from fast to slow rotators. All these results successfully reproduce the key observations and capture the V-P gap in a self-contained model.

Session III: *Solar and Stellar Seismology*

14:00 – 14:30

Ariane Schad: Global helioseismic measurement of meridional circulation and differential rotation from mode eigenfunction perturbations

Authors: Ariane Schad, Markus Roth

I will discuss recent helioseismic measurements of the meridional circulation and solar rotation from analysis of mode eigenfunction perturbations. The results are obtained from analysis of MDI data covering 2006-2010 and from HMI data covering 2010-1014. The method is verified using numerical simulations.

14:30 – 14:50

S.P. Rajaguru: Deep structure of solar meridional circulation: helioseismic inferences from four years of HMI/SDO observations

Authors: S.P. Rajaguru (Indian Institute of Astrophysics), and H.M. Antia (Tata Institute of Fundamental Research)

We present results from time-distance helioseismic measurements of meridional circulation in the solar convection zone using 4 years of Doppler velocity observations by the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO). We show, by taking into account the limitations of decreasing signal-to-noise in the travel time measurements of acoustic waves that sample deeper layers and through an in-built mass conservation constraint in the inversion scheme, that the return flow that closes the meridional circulation is possibly below a depth of about 0.77 R_{sun}. We discuss the significance of this result in relation to other helioseismic inferences published recently and possible reasons for the differences in the results. We also discuss the implications of our results for the dynamics of solar interior and popular solar dynamo models.

14:50 – 15:10

Ruizhu Chen: Measurement of deep solar meridional flow and its temporal variation

Authors: Ruizhu Chen, Junwei Zhao

Time-distance helioseismic analysis can detect flows in the solar interior, by inverting measured acoustic travel-time shifts. For solar meridional flow, the preciseness of such measurements is limited by a systemetic center-to-limb (CtoL) effect, which dominates the measured travel-time shifts. After removing a proxy of CtoL effect, previous works have detected an equatorward flow beneath the shallow poleward flow.

In this work, we develop a new measurement strategy that is able to disentangle the meridional-flow-induced signals from the CtoL effect in a more robust way. On each disk-radial direction, we track waves between any pair of locations. The measured travel-time differences between waves along a same ray-path but in opposite directions, are functions of geometric parameters: disk-centric distance, skip distance, and azimuthal angle of the measurement direction relative to the equator. The flow-induced time shifts and the CtoL effect add up to these measured signals, and they behave as independent functions of the geometric parameters, so these two quantities can be decoupled by solving linear equation sets in a least-square way. The isolated flow-induced time shifts are used to invert for the meridional flow. We justify the measurement strategy by applying it on a series of simulation datasets with either single-cell or double-cell meridional- circulation profile, with or without an artificial CtoL effect on top of the simulation data.

We make a comprehensive measurement on 4 years of SDO/HMI Doppler-velocity data using this new measurement strategy. Here we show the isolated CtoL effect and inversion results of solar meridional flow. We discuss the isotropy and other properties of the CtoL effect for the HMI data, as well as the temporal variation of the meridional flow.

15:10 – 15:30

Dean-Yi Chou: Solar-Cycle Variations of Meridional Flows and Magnetic Signature at the Base of Convection Zone

Authors: Dean-Yi Chou and Zhi-Chao Liang

Where solar magnetic fields are generated is a central issue in solar physics.

We use the solar-cycle variations of meridional flow to probe the magnetic field near the base of the convection zone (BCZ). Using the SOHO/MDI data, we measure the latitudinal distribution of travel time difference for different travel distances, corresponding to meridional flow signals in the solar interior down to 0.54R, over 15 years. Two systematic effects, the surface magnetic effect and the center-to-limb effect, are removed.

The travel time differences at the maximum and the minimum behave differently in three different depth ranges. The travel time difference at the maximum is greater than that at the minimum in the region above the BCZ, while smaller in the region around the BCZ; both are close to zero below the BCZ. The difference in travel time difference between the maximum and the minimum changes about 0.1 sec from the region above the BCZ to the region around the BCZ, corresponding to a change in flow velocity of about 10 m/s around the BCZ, equivalent to a field strength of 2,000 gauss at the BCZ.

If the change in travel time difference around the BCZ is caused by the magnetic field variations around the BCZ, this value is approximately the lower limit for the change in averaged field strength from the minimum to the maximum around the BCZ, based on an order-of-magnitude estimate.

15:30 – 15:50

Rosaria Simoniello: Helioseismic Signatures of the Progression of Solar Cycle: A Reflection of a Dynamo Wave

Authors: R.Simoniello, S.Tripathy, K.Jain

The onset of solar cycle at mid-latitudes, the slowdown of the sunspot drift toward the equator and the overlap of successive cycles at the time of activity minimum are delicate issues in αΩ and flux transport dynamo models. Very different parameter values produce similar results, making difficult the goal of achieving a unified dynamo model. In this work we use GONG helioseismic data to investigate the progression of solar cycle as observed in intermediate-degree global *p*-mode frequency shifts at different latitudes and depths, since the beginning of solar cycle 23 up to the maximum of current solar cycle. We also analyze those for high-degree modes in each hemisphere obtained through the ring-diagram technique of local helioseismology.

The analysis highlighted differences in the progression of the cycle below 15° compared to higher latitudes at all depths. While the cycle starts at mid-latitudes and then migrates poleward, below 15°, the sunspot eruptions of the old cycle is still on, leading to a tail like structure at the minimum epoch. Soon after the quiescent phase the activity steepen, while the descending phase is characterized by a slower decay compared to higher latitudes.

Based on our findings we envisage that, the α turbulent effect as well as the Babcock-Leighton mechanism are key ingredients in stellar dynamos, simultaneously operating and taking over each other depending on the cycle phase.

16:20 – 16:40

Charles S. Baldner: Variations in Large-scale Flow Structures in the Current Solar Cycle

Authors: Charles S. Baldner, Richard S. Bogart, Sarbani Basu

Recent work using data from the Helsioseismic and Magnetic Imager (HMI) on the Solar Dynamics Observatory (SDO) spacecraft has found coherent structures in solar flows at high latitudes that persist for multiple rotations (Hathaway et al. 2013, Bogart et al. 2015). These structures appear predominantly as narrow bands of retrograde or prograde flows. The significance of these structures is still being explored. We will discuss progress in further characterizing these features using ring-diagram analysis from the HMI data pipeline. Our work is focused on two areas: determining the extent in depth that these structures span, and measuring their motion relative to solar rotation.

16:40 – 17:00

Rudolf Komm: Large-scale subsurface flows during Solar Cycle 23 and 24

Authors: Komm, R., Howe, R., Hill, F.

We study the solar-cycle variation of the zonal and meridional flow in the near-surface layers of the solar convection zone from the surface to a depth of about 16 Mm. We have analyzed Dopplergrams obtained with the Michelson Doppler Imager (MDI) onboard the Solar and Heliospheric Observatory (SOHO), the Global Oscillation Network Group (GONG),and the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO) with a dense-pack ring-diagram analysis. The three data sets combined cover almost two solar cycles. The zonal and meridional flows vary with the solar cycle. Their amplitude variation tracks the mean latitude of activity and appears about three years before magnetic activity is visible in synoptic maps of the solar surface. We focus on the variation of the zonal and meridional flows, including their long-term variation at mid- and low-latitudes using GONG and MDI data and their variation at the high latitudes that are now accessible using HMI data. We will present the latest results.

17:00 – 17:20

Anne-Marie Broomhall: Statistical searches for low signal-to-noise oscillations

Low-frequency solar p modes have long lifetimes and, therefore, narrow peaks in frequency-power spectra. This allows their frequencies to be obtained very precisely, making them useful inputs for inversions of the solar interior. However, these low-frequency p modes have limited sensitivity to the solar core, which is still relatively poorly constrained. Mixed and gravity modes, on the other hand, are far more sensitive to core regions. Low-frequency p modes, mixed modes, and gravity modes are all difficult to detect because they have relatively small amplitudes and because they are swamped by solar noise from, for example, convection. We have developed statistical techniques to try and uncover these low signal-to-noise modes. We have then used these techniques to search for previously undetected low-frequency oscillations in BiSON and GONG data, considering the data sets both individually and contemporaneously. To uncover the modes we have developed both frequentist and Bayesian approaches. The developed techniques are very flexible and could be useful for asteroseismic studies as well as helioseismology.

17:20 – 17:40

Kaori Nagashima: Measurement of the amplitude of the solar cross-covariance function

Authors: Kaori Nagashima, Laurent Gizon, Aaron C. Birch, Damien Fournier

In current time-distance helioseismology analyses the (phase) travel time is commonly used. However, other than the travel time, there are parameters of the cross-covariance functions of the solar oscillation field that are affected by solar interior structure and dynamics. Including these parameters in helioseismology analyses might improve the analyses. Therefore, here we focus on one such parameter, the amplitude. We formulate a two-parameter fit of the cross-covariance function in the regime where the amplitude and travel-time differences of the cross-covariance function are small, and measure amplitudes as well as travel times in several areas on the Sun. We find that the amplitude of the center-to-annulus cross-covariance function in the quiet Sun shows the supergranulation pattern, although the amplitude is noisier than the travel times; the out-in amplitude difference shows positive correlation with the out-in travel-time difference. We also detect significant amplitude reduction due to sunspots, which is consistent with Liang et al. (2013).

17:40 – 18:00

Vincent Böning: Validating Spherical Born Kernels for Meridional Flows

Authors: Vincent Böning, Markus Roth, Jason Jackiewicz

We present the current status of an ongoing validation of a recently developed model for computing spherical Born approximation sensitivity functions for flows. In a first step, power spectra and reference cross-correlations from the model and a simulation of Hartlep et al. (2013) are matched. Some difficulties in obtaining such a match are discussed. In a second step, travel times from the forward model and from the simulation, which includes a standard meridional flow profile, are to be compared. The analysis procedure including the use of phase-speed filters is identical to the one employed in Jackiewicz et al. (2015). Furthermore, we present a novel approach for a fast computation of integrated sensitivity functions which can be used for interpreting rotationally symmetric flows such as differential rotation and meridional flow.

18:00 – 18:20

Björn Löptien: Data Compression for Helioseismology

Authors: B. Löptien, A. C. Birch, T. L. Duvall Jr., L. Gizon, and J. Schou

Several upcoming space missions, such as Solar Orbiter, are going to be very limited in telemetry and will have to perform extensive data compression. In particular, it will probably be necessary to implement lossy methods, which involve a trade-off between the compression efficiency and artifacts caused by the compression. Here we evaluate the influence of lossy compression on time-distance helioseismology and local correlation tracking of granulation (LCT). Starting from tracked and remapped Dopplergrams (for time-distance helioseismology) and continuum intensity images (for LCT) provided by the Helioseismic and Magnetic Imager (HMI), we test the performance of various compression methods (quantization and JPEG compression in combination with smoothing and subsampling in case of time-distance helioseismology or a reduced number of continuum images for LCT). We show that both time-distance helioseismology of supergranulation and measurements of differential rotation with LCT are possible using input data with a size of less than one bit per pixel. Quantization is the best method tested for LCT. For time-distance helioseismology, JPEG compression gives the best results. This suggests applying different compression methods to the Dopplergrams used by local helioseismology and the continuum images used by LCT.

Wedensday, September 2, 2015

9:00 – 9:20

Damien Przybylski: Signatures of mode conversion in a sunspot simulation**.**

Measurements made around active regions are complicated by magneto-acoustic mode-conversion and changes in the radiative properties of magnetic field concentrations. Forward modelling has been performed using the SPARC numerical code in a semi-empirical magneto-hydrostatic model of a large-scale solar magnetic field mimicking a sunspot. The 6173 A absorption line used by the HMI instrument has been synthesized at various positions on the solar disk. Using the response of this spectrum at different observational inclinations slow modes are seen in the sunspot umbra.

9:20 – 9:40

Khalil Daiffallah: Helioseismology of sunspot models

We use numerical simulations to investigate the interaction of an f-mode wave packet with models of sunspot in a stratified atmosphere. We focus on the scattering from hexagonal compact cluster model. We have shown that this model have a specific behavior in comparison to monolithic tube of the same size. However, no signature of multiple-scattering regime has been observed, which means that this regime occurs only for a loose cluster. These results are a contribution to the effort to discern seismically between different magnetic structures by observing their signatures on the scattered wave field in solar surface.

09:40 – 10:00

Rudolf Komm: Subsurface helicity of active regions 12192 and 10486

Authors: Komm, R., Tripathy, S., Howe, R., Hill, F.

The active region 10486 that produced the Halloween flares in 2003 initiated our interest in the kinetic helicity of subsurface flows associated with active regions. This lead to the realization that the helicity of subsurface flows is related to the flare activity of active regions. Eleven years later, a similarly enormous active region (12192) appeared on the solar surface. We plan to study the kinetic helicity of the subsurface flows associated with region 12192 and compare it to that of region 10486. For 10486, we have analyzed Dopplergrams obtained with the Michelson Doppler Imager (MDI) onboard the Solar and Heliospheric Observatory (SOHO) and the Global Oscillation Network Group (GONG) with a dense-pack ring-diagram analysis. For 12192, we have analyzed Dopplergrams from GONG and the Helioseismic and Magnetic Imager (HMI) onboard the Solar Dynamics Observatory (SDO). We will present the latest results.

10:00 – 10:20

Johannes Löhner-Böttcher: Magnetic field reconstruction based on sunspot oscillations

Authors: Johannes Löhner-Böttcher, Nazaret Bello González

The highly dynamic solar atmosphere exhibits a wealth of MHD modes. The strong magnetic fields of sunspots guide these waves from the lower to the upper atmosphere. The most dominant phenomena are the bright umbral flashes and running penumbral waves. As found by Bel & Leroy (1977) and De Pontieu et al. (2004), the cut-off frequency for the propagating waves depends on the ambient sound speed and the inclination angle of the magnetic field lines. From an observational point of view (see Löhner-Böttcher & Bello González 2015), we investigate the dominant frequencies present in sunspots. A 1h-time series of multi-wavelength observations of NOAA11823 taken at high spatial and temporal resolution with ROSA and IBIS at the DST is analyzed. The spatial distribution of peak frequencies for a fine sample of photospheric to chromospheric layers is revealed. Going one step further, we present the successful height-sampled reconstruction of the magnetic field inclination for a sunspot. The results agree to the inclinations obtained by HMI inversion and potential magnetic field extrapolations (PFSS).

10:50 – 11:10

Ângela Santos: Contribution from sunspots to the observed frequency shifts

Authors: A. R. G. Santos, M. S. Cunha, P. P. Avelino, T. L. Campante, W. J. Chaplin

The frequencies of the solar oscillations are known to vary in phase with the Sun's activity level. The solar cycle is accompanied by changes in the overall magnetic field as well as in the area covered by active regions, which can affect the wave propagation, hence, the oscillation frequencies, through direct and indirect effects. However, the importance of the different contributions is not well established. With this in mind, we developed an empirical model to estimate the spot-induced frequency shifts. The model assumes the sunspot properties, such as the time dependent latitudinal distribution and area and a characteristic induced phase difference that represents the local impact of a spot on the wave. We have applied our model to the sunspot daily records (from NGDC/NOAA) and synthetic sunspot data. By comparing the frequency shifts obtained with our model using real sunspot data with those observed, we are able to estimate that the contribution from spots to the observed frequ ency shifts is about 30%.

11:10 – 11:30

Kiran Jain: Response of Solar Oscillations to The Magnetic Activity: Comparison between Solar Cycles 23 and 24

Authors: Kiran Jain, Sushant Tripathy, Frank Hill and Rosaria Simoniello

The intermediate-degree mode parameters are used to study the variability of solar oscillations and their dependence on the magnetic-activity. Here, we use uninterrupted observations from two sources; the ground based obervations are from a 6-site network, GONG, for about 20 years that covers a period from the minimum of cycle 23 to the declining phase of cycle 24, and the observations from space are from SOHO/MDI and SDO/HMI covering almost the same period as in the ground-based observations. Using the frequencies for cycle 23, we have earlier demonstrated that the frequencies do vary in phase with the solar activity indices, however, the degree of correlation differs from phase to phase of the cycle; the mode frequency shifts are strongly correlated with the activity proxies during the rising and declining phases whereas this correlation is significantly lower during the high-activity period. In this paper, we extend our analysis to other mode parameter, viz., amplitude and line width, compare results for solar cycles 23 and 24, and try to understand the origin of the similarities/differences between both cycles.

11:30 – 11:50

Jesper Schou: What to do Next in Global Mode Seismology?

Helioseismic data have been analyzed using global mode techniques for a long time. Yet, there are still several different codes in use with different assumptions, approximations, limitations and, in many cases, systematic errors.

Here I will discuss why this is, what we might do about the problems and what we might learn, if successful.

I will also show some recent result illustrating what might be learned.

Thursday, September 3, 2015

9:00 – 9:30

Sarbani Basu: Seismic inferences of solar and stellar structure

The seismic study of the Sun and other stars offers a unique window into the interior of these stars. Helioseismic data have allowed us to determine the structure and dynamics of the Sun very precisely. In fact the high-precision data allow us to use the Sun as a laboratory to study properties of matter.

Asteroseismology, the seismic study of other stars, has made tremendous progress in recent years because of missions such as CoRoT and Kepler. We are beginning to be able to use asteroseismic data to study the interior of other stars.

In this talk I shall discuss how and what we have learned about the Sun using helioseismic data, and how we have modified the techniques to make inferences about other stars and what we have learned about them so far.

9:30 – 9:50

George Angelou: On the Utility of Diagrams of Small Frequency vs Large Frequency Separation

Authors: George Angelou, Saskia Hekker, Elisabeth Guggenberger, Nathalie Themessl

Over 35 years ago, it was proposed that there exists diagnostic potential in combining the small and large frequency separations for solar-like oscillators.

Since then, we have been spoilt with a plethora long-timeseries photometric light curves from which individual stochastic oscillation modes can be extracted. These light curves allow the separations to be determined en masse and in power spectra with relatively low signal-to-noise ratios.

The small-frequency separation in low-mass main-sequence stars and in subgiants is sensitive to the molecular weight gradient in the inner regions whilst the large-frequency separation is indicative of the mean density of the star.

We investigate how accurately these parameters must be determined in order to place constraints on stellar parameters such as mass and age. We discuss some difficulties associated with calculating the necessary large grids of models (with different input physics) as well as the degeneracy that exists in later evolutionary phases.

9:50 – 10:10

Elisabeth Guggenberger: Towards an improvement of the scaling relations

Authors: E. Guggenberger, S. Hekker, S. Basu, G. Angelou and N. Themessl

Scaling relations are an essential tool to derive fundamental stellar properties such as mass and radius from asteroseismic parameters.

The scaling relations are based on the assumption that the internal structures of the analysed stars are homologous to that of the reference, often the Sun. This assumption may not always be fulfilled, given that stars evolve and thereby change their structure significantly.

In our study we take a novel approach by identifying parameter ranges in which the assumption of homology is true for a given group of stars.

We use a grid of models covering a large range of masses and metallicities. We present preliminary results on several aspects of the model structures, which can indicate homology. The goal is to find regions in the parameter space in which homology can safely be assumed and to find appropriate reference values and/or correction functions for the scaling relations in each homology region.

10:10 – 10:30

Mutlu Yildiz: Effects of the HeII ionization zones on oscillation frequencies and their promises

Low amplitude is the defining characteristic of solar-like oscillations.

The space projects *Kepler* and *CoRoT* give us a great opportunity to successfully detect such oscillations in numerous targets.

Achievements of asteroseismology depend on new discoveries of connections between the oscillation frequencies and stellar properties. In the previous studies, the frequency of the maximum amplitude and the large separation between frequencies were used for this purpose. In the present study, we confirm that the large separation between the frequencies has two minima at two different frequency values. These are the signatures of the He II ionization zone, and as such have very strong diagnostic potential. We relate these minima to fundamental stellar properties such as mass, radius, luminosity, age and mass of convective zone. For mass, the relation is simply based on the ratio of the frequency of minimum to the frequency of maximum amplitude.

These frequency comparisons can be very precisely computed, and thus the mass and radius of a solar-like oscillating star can be determined to high precision. We also develop a new asteroseismic diagram which predicts structural and evolutionary properties of stars with such data. We derive expressions for mass, radius, effective temperature, luminosity and age in terms of purely asteroseismic quantities. For solar-like oscillating stars, we now will have five very important asteroseismic tools (two frequencies of minimum $\Delta\nu$, the frequency of maximum amplitude, and the large and small separations between the oscillation frequencies) to decipher properties of stellar interior astrophysics.

11:00 – 11:30

Maria Bergemann: Chemical abundances of the Sun and solar-like stars

Stellar spectroscopy is a unique instrument to understand the physics of stars. Chemical abundances observed in stars tells us about cosmic nucleosynthesis, the properties of the interstellar medium at the time when stars were born, and secular processes that influenced the evolution of a star throughout its lifetime, such as the accretion of planetary material. It has now been established that stellar abundance peculiarities may hold clues to physics of planet formation. I will review the state-of-the-art in modelling spectra of cool solar-like stars, which are the ones where we eventually expect to find Earth-like planets. I will then describe the ongoing and future efforts to determine and understand the chemical composition of the Sun and solar-like stars, and summarise how these exciting observations impact our understanding of the structure and evolution of stars and planets.

11:30 – 11:50

Vincent Ballenegger: Thermodynamic properties of hydrogen and hydrogen-helium mixtures under solar conditions

Authors: V. Ballenegger, A. Alastuey and D. Wendland

The equation of state of the hydrogen-helium mixture is an important ingredient in the modeling of the Sun and of other stars. The virial expansion provides accurate predictions for the thermodynamical properties when the gas is almost fully ionized (as for instance sufficiently deep in the Sun interior), but this expansion fails to converge in the cooler outer regions because of the formation of helium and hydrogen atoms [1,2]. We have derived a new exact expansion for the equation of state of the (pure) hydrogen gas that does converge for any ionization ratio [3]. Our so-called SLT expansion provides the exact first few corrections to the ideal Saha equation of state for a partially ionized hydrogen gas. The first five terms in the expansion have been computed and are given by fully explicit analytical formulas which are simple to implement [3,4]. The SLT expansion is derived within the physical picture where the hydrogen gas is described as a quantum system of point electrons and protons interacting via the Coulomb potential, similarly to the well-known OPAL equation of state [5]. Our calculations are based on fugacity (or activity) series in which the effects of interactions between the quantum particles are described exactly by quantum Mayer diagrams (this differs from the OPAL approach where a classical analysis is first performed, with classical expressions later replaced by their quantum analogues). Besides the SLT expansion, we have computed numerically further Mayer diagrams to study the equation of state of the hydrogen-helium mixture. Comparisons of our predictions with the OPAL tables for various properties (pressure, internal energy, adiabatic exponent) have shown a good agreement, at least for thermodynamic conditions corresponding to the solar adiabat [6].

References

[1] A. Alastuey and A. Perez, Europhys. Lett. 20, 19 (1992)
[2] A. Perez, K. Mussak, W. Däppen and D. Mao, A&A 505, 735 (2009)
[3] A. Alastuey, V. Ballenegger, Ph. Martin and F. Cornu, J. Stat. Phys. 130, 1119 (2008)
[4] A. Alastuey and V. Ballenegger, Phys. Rev. E 86, 066402 (2012).
[5] F. J. Rogers, F. J. Swenson, and C. A. Iglesias, Astrophys. J. 456, 902 (1996).
[6] D. Wendland, Ph.D. thesis (unpublished)

11:50 – 12:10

Antonio Ferriz-Mas: Chandrasekhar's 'adiabatic exponents' and other material coefficients for stellar interiors.

On dealing with stellar interiors one comes across an indeterminate number of thermodynamic coefficients such as c_p and c_v (specific heats at constant pressure and volume), c_S^2 (squared sound speed), α (thermal expansion) and β (isothermal compressibility).

In the context of helio- and asteroseismology other less well-known coefficients appear, such as Chandrasekhar's adiabatic exponents and others (e.g., ξ_ρ or ξ_T). The thermodynamics of stellar interiors – and, in particular, the fundamental constitutive relations – is traditionally presented with a flavour of 'cook-book' approach in which rules, that are ultimately Jacobian transformations, are given which relate the different coefficients.

In helioseismology use is made of the dimensionless adiabatic exponents Γ_1, Γ_2 and Γ_3, which were introduced by Eddington and Chandrasekhar in the context of stellar interiors (they were historically introduced having in mind a mixture of ideal gas and black-body radiation). They are material coefficients (i.e., response functions) of fluid systems. Since a simple algebraic relation among the three Γ's exists, they cannot form a complete set of material coefficients. The reason why the Γ's are useful is because with their help it is possible to write many expressions in a manner which is formally the same as for ideal gases even when the fluid under consideration is not an ideal gas.

In this contribution I present a systematic derivation of several equivalent complete sets of material coefficients for a fluid system of constant chemical composition, among which the set $\{\Gamma_1, \Gamma_3, c_v\}$ or the more customary set $\{\alpha, \beta, c_p\}$ are treated as special cases. Whether the system is a mixture of ideal gas and black-body radiation, a degenerate stellar interior or whatsoever is irrelevant as long as it is an isotropic material. How to extend the approach to systems of varying chemical composition (including diffusion) is briefly sketched.

The main aim of this contribution is to shed light onto the apparent mess of the zoo of thermodynamic coefficients used in stellar interiors and develop a systematic approach to this topic.

11:50 – 12:10

Ehsan Moravveji: Tight asteroseismic constraints on core overshooting and diffusive mixing for massive stars

Authors: Ehsan Moravveji, Conny Aerts, Peter Papics, Santiago Triana

Thanks to the unprecedented high quality space photometry provided by CoRoT and Kepler missions, our view on stellar oscillations in B-type stars and the physics of the upper HRD is progressively improving. O- and B-type stars harbor a fully mixed convective cores, and a radiative envelope. However, the interface between these two layers -- the so-called overshooting layer -- is not understood from first principles. Thus, the width and the mixing efficiency of the overshooting layer is always treated by simplistic schemes like step-function or exponentially diffusive mixing prescriptions. We modelled two rich main sequence pulsators observed by Kepler and CoRoT which also turn out to be very slowly rotating pulsating B stars. They are KIC 10526294 and HD 50230, respectively.
Based on forward seismic modelling, we derive the width of the overshooting layer on top of their receiding cores. Additionally, we show that extra diffusive mixing of 100 to 10 000 cm^2/sec in the radiative envelope of these two stars is essential to better fit their observed g-mode frequencies. We also compare the classical step-function versus exponential diffusive overshoot.
The diffusive overshooting prescription outperforms the other to fit the observed frequencies by a factor 2 to 3 (in chi^2 sense). The derived values for the overshooting and diffusive mixing coefficients are weakly dependent on the choice of opacities and chemical mixtures, and are considered robust constraints.

12:10 – 12:30

Gaël Buldgen: Constraining mixing processes in 16CygA and 16CygB using Kepler data and seismic inversion techniques

Authors: Gaël Buldgen, Marc-Antoine Dupret, Daniel Roy Reese

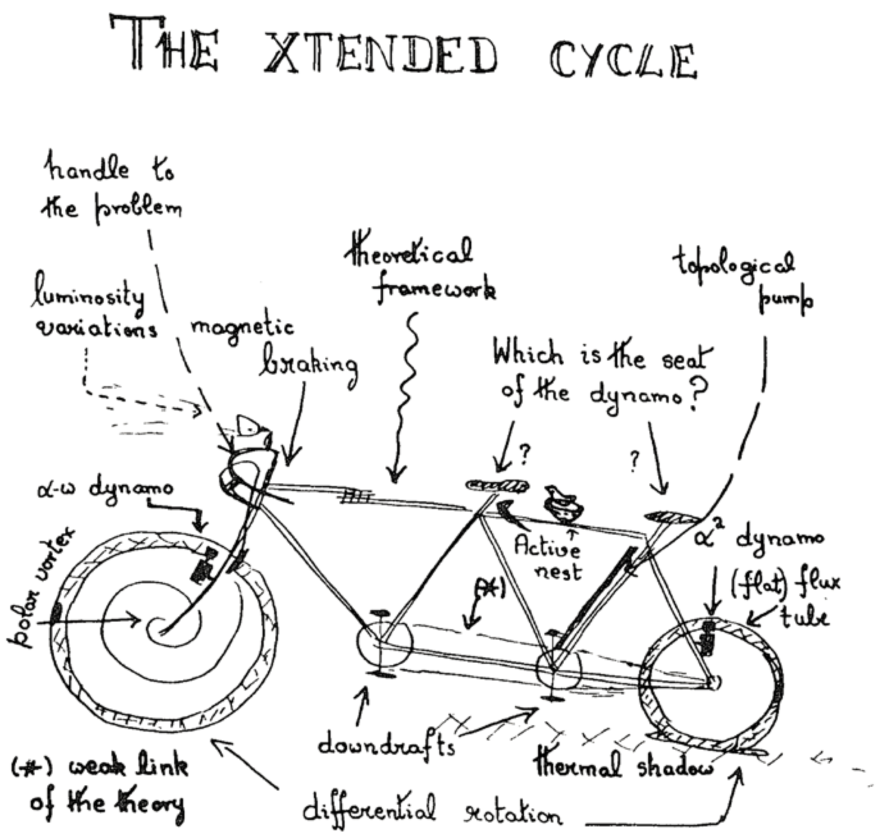
Constraining additional mixing processes is a central problem in stellar physics. Indeed, their impact on determined stellar ages is non-negligible and thus strongly affects our studies of stellar evolution, galactic history, and exoplanetary systems. However, the quality of the Kepler data allows us to use new seismic tools to constrain these processes. In this talk, we will show a particularly efficient method for constraining chemical mixing in stellar interiors using custom-made structural integrated quantities. These quantities are designed to probe particular regions of the stellar interior and are estimated via the SOLA inversion method (Pijpers and Thompson 1994). They help us determine the values of parameters describing extra mixing processes. Inversions of such quantities have been originally described for the mean density in Reese et al. (2012) and have been extended to the acoustic radius and a first indicator of core conditions in Buldgen et al. (2015). A more efficient indicator for core conditions has now been derived and successfully tested using test cases similar to the 16Cyg binary system (Buldgen et al. in prep.). In this talk, we will show how our technique applies to the system 16Cyg and constrains additional mixing processes using the above structural indicators. Additional indicators and further studies will lead to seismically constrained chemical profiles for stars observed by Kepler, thereby helping us to disentangle the problem of additional mixing processes and ultimately to provide better stellar ages.

Session IV: *In Memory of Jean-Paul Zahn*

14:15 – 14:45

Stéphane Mathis & Ian Roxburgh: A Tribute to Jean-Paul Zahn

ON THE LIGHT SIDE . . . .



Drawing by Jean-Paul Zahn, lettering by Sydney D'Silva, and words by several happy "cylists"

"The researches of many commentators have already
thrown much darkness on this subject,
and it is probable that if they continue,
we shall soon know nothing about it at all."

- Mark Twain

From:
ASP Conf. Series Volume 27 (1992) page 559.

The Solar Ccyle

Edited by
Karen L. Harvey

Proceedings of the NSO / Sacramento Peak 12th Summer Workshop, 15 – 18 October 1991

14:45 – 15:15

Sebastien Deheuvels: What asteroseismology is teaching us about the internal rotation of stars

It is notoriously difficult to measure how the interior of stars rotate. So far, this has hindered our progress in stellar modeling because rotation is expected to play a central role in the evolution of stars. The inversion of the internal rotation profile of the Sun obtained from helioseismology in the 90's has revolutionized the field and shown that an efficient and yet unknown mechanism that transports angular momentum operates in the Sun. The space missions CoRoT and Kepler, launched in 2006 and 2009 respectively, have finally made it possible to probe the internal rotation of stars other than the Sun using seismology. In this review talk, we give an overview of the results that were obtained so far, which cover an ever growing part of the HR diagram, from the main sequence (inversions of the rotation profile are starting to be obtained for A, F, and B-type hybrid pulsators) to subdwarf B stars and white dwarfs. A special attention will be given to red giants, in which the detection of so-called mixed modes has made it possible to measure the core rotation rate in several hundreds of targets and to quantify radial differential rotation from the subgiant phase to the core-helium burning phase. These exciting results are giving new momentum to theoretical works tackling the question of angular momentum transport in stars by providing unprecedented observational constraints. We briefly discuss the results of some of the latest studies.

15:15 – 15:35

Santiago Andres Triana: The internal rotation of stars as revealed by asteroseismic inversions

Authors: Santiago Andres Triana, Joris De Ridder, Enrico Corsaro, Peter Papics, Ehsan Moravveji & Conny Aerts

The frequencies of non-axisymmetric stellar pulsations are shifted by internal flows in a star. A pulsation mode with angular degree l is *rotationally split* into $2l+1$ components. Observations of these rotational splittings for modes with different radial wave numbers can therefore provide information on the internal rotation of the star. This technique has been particularly successful in the Sun and only relatively recently, with the advent of space-based photometry (CoRoT, Kepler), it has been possible to resolve internal rotation profiles on other stars. During this talk we will present recent results on the internal rotation of a B-type star as deduced from the rotational splittings of its g modes. We present as well the internal rotation profiles of a sample of young red giants as deduced from the splittings of their so-called mixed modes. Some theoretical challenges brought by these observations will be discussed.

16:15 – 16:35

Vincent Prat: Ray dynamics of gravito-inertial modes in rapidly rotating stars

Authors: V. Prat, F. Lignières, J. Ballot

Seismology of intermediate-mass and massive stars is limited by our lack of understanding of the effect of fast rotation on gravity modes.
In particular, in this regime perturbative methods are unable to identify observed modes.

We therefore develop an asymptotic theory for adiabatic gravito-inertial modes in uniformly rotating stars.
We first derived a generalized dispersion equation taking the Coriolis force and the centrifugal deformation into account.
The corresponding ray dynamics allowed us to explore the structure of the phase space thanks to a ray-tracing code.
We observed three coexisting types of structures: (i) nearly integrable structures similar to non-rotating structures, (ii) island chains around stable periodic orbits, (iii) large chaotic zones.
These three different types of structures are expected to give three different families of modes.

16:35 – 16:55

Paul G. Beck: Seismic analysis of red giant stars in binary systems - the heartbeat of red giants

Authors: Paul G. Beck, Rafa A. Garcia, Tugdual Ceillier, Stephane Mathis, Thomas Kallinger, Kresimir Pavlovski

The growing number of binary stars with oscillating components from Kepler space photometry (Beck et al. 2014, Gaulme et al. 2014) or ground-based spectroscopy (Beck et al. 2015) provides a large sample of rewarding objects to study stellar physics. Besides the classical eclipsing binaries, we also find various types of binaries through Kepler photometry, which show tidally induced flux modulation. A large arsenal of state-of-the art seismic, spectroscopic, and light curve analyses techniques at our disposal, allows us to constrain several parameters or test for physical processes independently.

Based on detailed case-by-case studies we discuss the interaction of stellar components in eccentric binary systems with one or even two oscillating red giant components. For those targets, we have good constraints on the masses, radii and rotation rates of both components through seismology. This allows us to derive independent inferences on the stellar structure and independent estimates of the fundamental parameters. Of special interest are double-lined binary systems with oscillating components, such as theta1Tauri, a red giant in the open cluster of the Hyades, for which the recently derived dynamical masses can be confronted with the seismically determined values. Important aspects for the understanding of the system are also the synchronization as well as stellar activity. While, judged from seismology or surface rotation some systems have stellar rotation rates on (nearly) the orbital, others do not show signs of synchronization at all. By combining the constraints derived from seismology with a detailed modeling of eclipses or ellipsoidal modulation and spectral disentangling techniques, we can therefore quantify the system parameters very precisely and even characterize the faint components.

16:55 – 17:15

Wiebke Herzberg: The effect of large scale flows on the eigenfrequencies of subgiant stars

Authors: Wiebke Herzberg, Markus Roth

It is well known that the presence of large scale flows leads to a coupling of oscillation modes through advection, which results in a shift of the eigenfrequencies of a star (Lavely and Ritzwoller, 1992). For the sun, these shifts are very small (of the order of nHz). Subgiant stars are candidates for bigger convection cells and higher flow velocities compared to the sun. Employing forward modeling with a subgiant stellar model and convective velocities from the MLT, we estimate the frequency shifts to first order with perturbation theory.

17:15 – 17:45

Guy Davis: Sounding solar and stellar activity cycles using seismology

The arts of helioseismology and asteroseismology allow us to peer under the surface of stars and infer both properties of internal structure and dynamics. Our Sun changes with a well known, but not well understood, activity cycle and these changes are observable using helioseismology. The changes observed by helioseismology can be seen when the Sun is treated as if it were a star. This had raised hopes that the Kepler and CoRoT space missions, that perform photometry on many stars, may allow for the study of solar-like stellar cycles using asteroseismology. But the signatures of stellar cycles in asteroseismic parameters are rarely seen. I will discuss results from helioseismology and the solar cycle before asking why have we not seen many stellar cycles using asteroseismology.

Friday, September 4, 2015

Session V: *Solar and Stellar Activity*

9:00 – 9:30

Thomas R. Ayres: The Ups and Downs of Stellar Activity

One of the oddest properties of late-type stars is their propensity to cycle magnetically. The solar cycle is the best studied, with reliable measurements of proxies -- sunspots -- dating back to the dawn of the telescopic age, some 4 centuries ago. The sunspot record shows a roughly eleven year periodicity in the emergence of the highly magnetized dark umbral regions, and a curious migration of the spot groups from high latitudes at the beginning of a new cycle, toward lower latitudes as the cycle progresses. Direct measurements of the associated magnetic fields have been made now for about a century, with the additional finding that the polarity of the global field reverses along with the cycle rise of the spots, leading to an overall magnetic cycle of about 22 years. Longer term modulations have been recognized in the historical records of daily sunspot numbers, including the remarkable Maunder Minimum period in the 17th Century when the spots mostly vanished for nearly 70 years. Even longer term trends in solar activity have been deduced from isotopic abundance anomalies, recovered from deep glacial ice cores and tree ring borings. The bi-decadal period of the Sun's global magnetic variation is much longer than any of the normal stellar timescales, such as rotation (about a month), convection (few days), and global acoustic oscillations (few minutes), and thus presents great obstacles to theoretical inference. For this reason, studies of the stellar analogs of the solar cycle have been carried out, now for about a half century, in an effort to gain insight into which properties of the stars might be influencing the magnetic oscillation. Most of these observational efforts have relied upon another cycle proxy, the Ca II H and K lines (near 395 nm), whose deep cores usually display a centrally reversed emission core of chromospheric origin. The Ca II core strengths vary over rotational and cycle timescales owing to the influence of the magnetic activity on enhanced chromospheric heating, especially in the bright “plage” regions surrounding the dark photospheric spots. Stellar cycles recovered in this way mainly are solar-like in decadal duration and Ca II amplitude, at least among stars of solar temperature and relatively slow rotation. Maunder-Minimum-like periods of depressed, unchanging Ca II emission also have been found, in something like 1 out of 5 sunlike stars. Notably, however, cycles seem to avoid the most active, fast rotating G- and K-type dwarfs, which mainly display large amplitude rotational variations. A recent addition to the stellar cycle tool box over the past decade is the use of orbiting X-ray and UV telescopes (such as Chandra and XMM-Newton for the former, and HST for the latter) to explore how the highest energy "coronal" emissions associated with the activity evolve over a stellar cycle. Only a few stars have been observed persistently by this technique -- nearby Alpha Centauri A (G2V) and B (K1V) are the best examples -- but the preliminary results are encouraging, in helping us understand how the much more extreme variations at the high energies (compared with Ca II) come about.

9:30 – 10:00

Svetlana Berdyugina: Overview on Sunspots and Starspots

To be announced.

10:00 – 10:30

Louise Harra: Review of solar flares

Over the past decades the understanding of solar flares has progressed significantly through the combination of increasingly better observations and simulations. New observations have included spectroscopic observations of the corona, transition and corona, and included wide energy ranges. High spatial resolution has been achieved, probing details of individual events. The space missions alongside the ground-based at that are observing the Sun have provided extensive detailed observations that support many aspects of the ‘standard flare model’. This model is based on magnetic reconnection occurring high in the corona. There are however observations that cannot be explained by the model. I will summarise work on case studies as well as statistical work. I will finish by discussing how solar observations can help stellar observations and the challenges involved in doing that.

11:00 – 11:20

Manfred Kitze: Superflares on solar analogue stars

Authors: Kitze, M; Hambaryan, V.V.; Neuhäuser, R.

Superflares are rapid and strong brightenings on stars similar to the sun ("solar-analog stars") (F8-G8). The total energy release of a superflare can reach values of 10^{33}-10^{35} erg. Kepler data have the potential to homogenously study the superflare frequency statistics on solar analog stars. Maehara et al. (2012) and Shibayama et al. (2013) estimated that a superflare of 10^{34} erg on a solar analog star can occur once every 800 yr, a superflare of 10^{35} erg every 5000 yr: this is based on 19 superflare stars.

However, several groups including us (Kitze et al. 2014) show that 10 of those 19 superflare stars (with corresponding temperatures 5600K $\leq T_{eff} \leq$ 6000K, log g $\geq$ 4.0 and $P_{rot} \geq$ 10 d) are dubious for further consideration, i.e. are not really solar-analog stars, e.g. are much younger than the sun or post-main sequence stars or binaries. E.g., we (Kitze et al. 2014) have shown that for one of the two most energetic superflares, the photons during the flare did not originate from the presumable sun-like star, but from another source nearby, either a companion or a background star. This lowers the amount of sun-like superflare stars by a factor of 2 and impacts the superflare statistics.

We present new results from analysing the whole sample of G0-G7-type Kepler stars for the whole period of Kepler observations on the base of an independent analysing strategy. We additionally use Kepler Astrometry to identify nearby objects, as possible causes for superflares and rejected such cases. Further we use Gabor Transform and Autocorrelation to determine rotational periods and their significance as a more reliable way. Finally we use gyrochronology to consider superflare activity as a function of the stellar age. Our work points towards a much lower superflare frequency.

11:20 – 11:40

Rekha Jain: Oscillations in a solar coronal arcade near a flare-site

Authors: Rekha Jain, R. A. Maurya and B. W. Hindman

I will present detection of intensity variations, as measured by the Atmospheric Imaging Assembly in the 171 Å passband, in two solar coronal loops embedded within a single coronal magnetic arcade. The oscillations were likely initiated by interaction of the arcade with a large wavefront issuing from a flare site. We find fundamental modes with periods of roughly 2 minutes and decay times of 5 minutes in both of the coronal loops. The power spectra of the oscillations evince signatures consistent with oblique propagation to the field lines and for the existence of a multi-dimensional waveguide instead of a one-dimensional one.

11:40 – 12:10

Alina Donea: Seismicity induced by solar and stellar flares: comparison

I will be discussing how solar flares induce seismic transients into the solar photosphere. I will also bring in the discussion stellar flares, and try to speculate on how seismic transients in stars can differ or not from those in the Sun.

12:10 – 12:30

Frederic Baudin: Flares and solar p-modes

Authors: F. Baudin, J. Leibacher, M.C. Rabello Soares

Flares have been suspected to excite solar p-modes since the 1970s. More recently, Karoff & Kjeldsen (2008) investigated flare excitation of global oscillations while Maurya et al. (2009, 2014) did a local analysis (ring diagrams) of flaring regions. We investigate these previous results by applying similar and different methods (ring fitting, l-nu diagrams) to similar and different data (GONG, MDI, HMI, VIRGO, GOLF) with the aim of confirming (or not) and extending these results. Particular attention is paid to possible biases in the analysis. This lead us to infirm some of the previous results, and to confirm others.

Posters

Solar Physics

P1

Aditi Sood: Suppression of kinematic dynamo by shear flow

Magnetic fields and shear flows play an important role in many systems including astrophysical, geophysical and laboratory plasmas.
We report how the growth of magnetic fields is modified by large-scale shear flow by investigating a kinematic dynamo in a spherical shell of highly conducting fluid surrounded by an insulator. A small scale prescribed velocity field is taken to be axisymmetric, steady and strongly helical. Small-scale flow is chosen in such a way it allows the dipole/quadrupole decoupling for magnetic field *B*. On the other hand, large-scale shear flows are taken to be in radial or latitudinal directions. By numerically solving induction equation with the prescribed small-scale flow and large-scale shear flow, we investigate the effects of large scale shear on dynamo for different azimuthal m modes for large magnetic Reynolds number R_m such as the growth rate and structures of magnetic field *B*. In all cases, the growth rate of the magnetic field is found to decrease as the strength of shear flow increases, which indicates that the dynamo is suppressed in the presence of shear.

P2

V. Senthamizh Pavai: Sunspot group, tilt angles and surface field reconstruction from historical observations

Authors: V. Senthamizh Pavai, Rainer Arlt

To understand the nature of the solar cycles, which aids in developing better dynamo models, long term statistical study of sunspot properties is needed. From analyzing historical sunspot drawings, we can obtain (i) solar cycle properties for many earlier cycles and (ii) improvements for empirical relations of sunspot emergence. The tilt angles of sunspot groups is an important property in flux-transport dynamo models in that it provides the source term for the poloidal magnetic field. With the improvement for the sunspot group properties, simulations of the polar-field and open-flux are performed.

We have analyzed the sunspot drawings of Samuel Heinrich Schwabe (1825 - 1867), Scheiner (1618, 1621, 1622, 1624 and 1625 - 1627) and Staudacher (1749 - 1796). The positions and umbral areas of sunspots were obtained from drawings. The Staudacher drawings are rough so the area values are not precise. The average tilt angle and Joy's law were obtained. The magnetic equator during 1825 - 1867 was also calculated. The empirical relations with latitude, cycle strength and phase used in sunspot emergence were tested for Schwabe data and it seems to work well. Using the surface flux transport model, the evolution of magnetic field on the surface of the Sun was then derived.

P3

Anne-Marie Broomhall: Quasi-periodic pulsations in stellar flares

Authors: Chloe Pugh, Valery Nakariakov, & Anne-Marie Broomhall

Quasi-periodic pulsations (QPPs) are a common feature of solar flares that are observed in many different wavelengths. Although QPPs appear not to be as abundant in white light Kepler flare light curves as they are in solar flares, albeit in different wavelengths the structure of the pulsations are strikingly similar, hinting that the same underlying processes govern both solar and stellar flares. Here we consider a special case, observed on KIC9655129, which shows evidence of multiple periodicities. We speculate that the presence of multiple periodicities is a good indication that the QPPs were caused by magnetohydrodynamic oscillations, further strengthening the case that the physical processes in operation during stellar flares are at least analogous to those in solar flares.

P4

M. Schüssler: The cause of the weak solar cycle 24

Authors: J. Jiang, R.H. Cameron, M. Schüssler

The ongoing 11-year cycle of solar activity is considerably less vigorous than the three cycles before. It was preceded by a very deep activity minimum with a low polar magnetic flux, the source of the toroidal field responsible for solar magnetic activity in the subsequent cycle. Simulation of the evolution of the solar surface field shows that the weak polar fields and thus the weakness of the present cycle 24 are mainly caused by a number of bigger bipolar regions with a 'wrong' (i.e., opposite to the majority for this cycle) orientation of their magnetic polarities in the North-South direction, which impaired the growth of the polar field. These regions had a particularly strong effect since they emerged within ±10° latitude from the solar equator. [Astrophys. J. 808, L28; 2015]

Helioseismology

P5

René Kiefer: 20 years of GONG: p-mode parameters and the solar cycle

Authors: René Kiefer, Rudolf Komm, Frank Hill

The properties of solar acoustic oscillations are known to vary with the solar cycle. With 20 years of continuous observations by GONG, we are now in the position to carry out a comparison of the variation of the p mode parameters between the last two solar cycles.

We present the results for analyses of width, amplitude, area (width x amplitude), and background amplitude of solar p modes, as well as the corresponding physical quantities for modes of harmonic degree $10 \leq l \leq 150$ of the global solar oscillations. We investigate the variation of these parameters for different ranges of mode frequency and harmonic degree.

We find that average mode widths are correlated with solar magnetic activity, while mode amplitudes and areas are anti-correlated to it. The fractional change in mode widths is largest for modes in the frequency range 2400-3300 μHz, regardless of harmonic degree, with an amplitude of ~10% between solar minimum and maximum. The fractional change in mode amplitude exhibits a peak-to-peak amplitude of ~30% over solar cycle 23. Also, we find hysteresis in mode amplitudes over cycle 23 for some combinations of mode frequencies and harmonic degree.

The physical quantities which correspond to the mode parameters (mean square velocity power, total mode energy, mode energy supply rate) are investigated as a function of time for different ranges of harmonic degree. We find that the mode energy supply rate decreased by ~20% over last 20 years. Whether this decrease is of solar origin, just an instrumental effect or was introduced during data reduction has yet to be investigated.

P6

Anne-Marie Broomhall: Empirical Mode Decomposition studies of quasi-biennial variations in helioseismic frequencies

Authors: Dmitrii Kolotkov, Anne-Marie Broomhall, & Valery Nakariakov

It is well-known that the Sun’s magnetic activity varies primarily on a time scale of 11yrs. It is also well known that the frequencies of the Sun’s natural acoustic oscillations vary in-phase with surface and atmospheric measures the Sun’s activity. Additionally, both atmospheric activity proxies and helioseimic frequencies exhibit variations on timescales much shorter than 11yrs, including the ‘quasi-biennial’ periodicity. Solar periodicities, including the 11yr cycle, are hard to characterise, as they vary in both length and amplitude. We have used empirical mode decomposition techniques to separate time variations in acoustic mode frequencies, the 10.7cm flux and sunspot areas into a set of intrinsic modes. We then use the Huang-Hilbert transform to characterise the periodicities of these intrinsic modes. The periodicities obtained are consistent between the different activity proxies, including the quasi-biennial periodicity. This indicates that the quasi-biennial behaviour observed at the solar surface and in the solar atmosphere is also symptomatic of the solar interior.

P7

Hui Zhao: Measurements of Absorption and Scattering Cross Sections for the Interaction of Solar Acoustic Waves with Sunspots

Authors: Hui Zhao; Dean-Yi Chou

Solar acoustic waves are scattered by Sunspots due to the interaction between the acoustic waves and sunspots. Based on our previous measured scattered wavefunctions, we are able to measure the absorption cross section and the scattering cross section versus radial order (n=0-5) for NOAA's 11084 and 11092. The ratio of absorption cross sections of two sunspots is the same as the ratio of two sunspot radii for all radial orders, while the ratio of scattering cross section is significantly different and varies with radial order. This suggests that the absorption cross section is linearly proportional to the sunspot radius, and that the regions responsible for absorption cross section and scattering cross section are different.

P8

M. C. Rabello Soares: Statistical analysis of the regions around and below a sunspot using acoustic waves

Authors: Rabello Soares, M.C., Bogart, R.S. & Scherrer, P.

The characteristics of solar acoustic waves are modified as they propagate through a sunspot due to changes in the properties of the solar interior. Detailed analysis of these variations has allowed us to study the changes in the structural and dynamic properties of the layers just below and around a sunspot, as well as changes in the excitation and damping of the modes in comparison with magnetically quiet region. Although much progress has been made, much more needs to be done to fully understand the sunspot structure below the photosphere and its interaction with the acoustic waves. In this work, instead of studying the characteristics of the waves in the active regions, we analyze magnetically quiet regions next to an active region (six degrees away) and compared with quiet areas away from any active region. To obtain the acoustic waves characteristics, we applied Ring-Diagram analysis to HMI Doppler observations obtained from May 2010 to January 2015.
We observed significant variations in the parameters of the waves. In addition to variations in their lifetime, we observed attenuations of their amplitude up to 16% for modes with frequency of 3 mHz. In the active regions, the waves are attenuated by 70% at this frequency. Waves with frequency higher than the acoustic cutoff frequency are amplified in a sunspot, a well known, but not well understood, phenomenon called "acoustic halo". In this work we found that waves with frequencies much lower than the cutoff frequency (around 4.2 mHz) are amplified in regions near the sunspot by as much as 20%.
The direction of the wave propagation (through the nearby sunspot or perpendicular to it) has a very small effect on the amplification (less than 3\%) and modes with frequency close to 4.6 mHz have the same amplification independent of their direction in relation the nearby active region.
The f modes are not amplified, for frequencies higher than 4.1 mHz, its variation is close to zero.
The rate at which energy is removed from the mode at the active region is approximately constant: (40 ± 10)%. While, at the nearby region, it is ~7% at 3 mHz and it is zero at 4.4 mHz until close the cut-off frequency.
Because of the obstruction to the heat transport created by the sunspot, a divergent horizontal flow has been observed around the sunspot in the deeper layers and, associated with it, a converging flow near the photosphere. We observed a 10 m/s outflow between 3 and 6 Mm deep at the neighboring regions to sunspot and possibly a small inflow (~3 m/s) between the photosphere and depth of 2 mm.

P9

Kiran Jain: Subsurface Flows within Active Regions

Authors: Kiran Jain, Sushant Tripathy and Frank Hill

Horizontal flows in the subsurface layers of active regions are calculated using the technique of ring diagrams and the Dopplergrams from SDO/HMI. Earlier attempts with the ring-diagram analysis were limited to the areas that were much bigger in size as compared to the active regions, thus the changes occurring within the active regions were not studied. The high-spatial resolution of HMI Dopplergrams allows us to determine flows in areas as small as 5 degrees in diameter. In this paper, we present results on the variation of horizontal flows in active regions with time and also in the sub-areas of individual magnetic polarity within the active regions. We find that the deeper layers show more variation in the velocity components than the near-surface layers demonstrating that the deeper layers are more affected by the topology of active regions/sub-regions.

P10

Richard Bogart: Overcoming Systematic Effects in Ring-Diagram Fitting

Authors: Richard Bogart, Charles Baldner, Sarbani Basu

Although the principles involved in understanding ring-diagram mode frequencies are well understood, the procedures for determining those frequencies in the power spectra of flattened geometries are plagued by several systematic effects which are not well understood. It is possible to overcome these effects in certain cases by comparing inversions of the fitted mode parameters, or just the parameters themselves, for particular targets with those for otherwise similar targets. We can thus draw useful information about features localized in both space and time, such as regions of anomalous flows or the thermal structures of active regions. But reliable measurements of the large-scale or long-term mean dynamical structure of the near-surface regions, particularly the profiles of differential rotation and meridional circulation, may require more robust estimations of the mode parameters than are presently available. We describe the known systematic effects in the extensive ring-diagram analysis of HMI Doppler data and explore some methods of overcoming or dealing with them.

P11

Vincent Böning: Modelling the Line-of-Sight Projection and Filtering-Induced Leakage in Time-Distance Helioseismology

Authors: Emmanuel Hecht, Vincent Böning, Markus Roth

In current approaches to time-distance helioseismology, the line-of-sight projection effect on the travel-times is not fully taken into account. Furthermore, filtering of full-disc data induces leakage due to the projection onto the CCD, which has so far not been accounted for. We develop a theoretical approach to consider these effects when computing sensitivity functions. As the formulas obtained do not seem to give results for spherical Born approximation sensitivity functions in a reasonable computation time, we develop tests to estimate the strength of the effects.

P12

Vincent Böning: Validating Spherical Born Kernels for Meridional Flows

Authors: Vincent Böning, Markus Roth, Jason Jackiewicz

We present the current status of an ongoing validation of a recently developed model for computing spherical Born approximation sensitivity functions for flows. In a first step, power spectra and reference cross-correlations from the model and a simulation of Hartlep et al. (2013) are matched. Some difficulties in obtaining such a match are discussed. In a second step, travel times from the forward model and from the simulation, which includes a standard meridional flow profile, are to be compared. The analysis procedure including the use of phase-speed filters is identical to the one employed in Jackiewicz et al. (2015). Furthermore, we present a novel approach for a fast computation of integrated sensitivity functions which can be used for interpreting rotationally symmetric flows such as differential rotation and meridional flow.

P13

Vincent Böning: Spherical Born Kernels for Flows in Time-Distance Helioseismology

Authors: Vincent Böning, Markus Roth, Wolfgang Zima, Aaron C. Birch, Laurent Gizon

We extend an existing Born approximation model for calculating the linear sensitivity of helioseismic travel-times to flows from Cartesian to spherical geometry. This development is necessary to use the Born approximation for inferring large-scale flows in the deep solar interior. Two consistency tests show that results for our sensitivity kernels agree with reference values to within a few percent. Consequently, we evaluate the impact of different data analysis filters on the kernels for a meridional travel-distance of 42 degrees. When mainly low-degree modes are used (roughly $l < 70$), the sensitivity is concentrated in deeper regions, otherwise the sensitivity is concentrated near the surface. Among the different low-degree filters used, we find the phase-speed filtered kernel to be best localized at depth. A kernel obtained with a narrow Gaussian filter in harmonic degree l is found to best resemble a ray-path like structure.

Asteroseismology

P14

René Kiefer: Determination of fundamental asteroseismic parameters using the Hilbert transform

Authors: René Kiefer, Ariane Schad, Wiebke Herzberg, and Markus Roth

Solar-like oscillations exhibit a regular pattern of frequencies. This pattern is dominated by the small and large frequency separations between modes. The accurate determination of these parameters is of great interest, because they give information about e.g. the evolutionary state and the mass of a star.

We present a novel method which is able to determine the large and small frequency separations for time series with low signal-to-noise ratio. Analyses of a time series of the Sun from the GOLF instrument aboard SOHO and a time series of the star KIC 5184732 from the NASA Kepler satellite by employing a combination of Fourier and Hilbert transform.
The method presented here uses the analytic signal of filtered stellar oscillation time series to compute the signal envelope. Spectral analysis of the signal envelope then reveals frequency differences of dominant modes in the periodogram of the stellar time series.

With the described method the large frequency separation $\Delta\nu$ can be extracted from the envelope spectrum even for data of poor signal-to-noise ratio. A modification of the method allows for an overview of the regularities in the periodogram of the time series. This overview can be used to get a first impression of the frequency range of the periodogram where regular patterns are present and for a first visual estimation value of e.g. the large separation.

P15

René Kiefer: Search for signatures of stellar activity cycles in the p mode frequencies of 25 solar-type stars observed by Kepler

Authors: René Kiefer, Ariane Schad, and Markus Roth

Several hundred stars were observed in the short cadence mode by the Kepler satellite during the nominal mission phase. This generated a large pool of data which can provide insight into the characteristics of stellar activity cycles of solar-type stars through the methods of asteroseismology. From helioseismology it is known that the frequencies of solar acoustic oscillations (p modes) are positively correlated with the solar magnetic activity cycle. Evidence for a similar behavior in the p modes of a star, which was observed by the CoRoT satellite, was provided by Garcia et al. in 2010. This showed that it is feasible to trace the activity cycles of stars in their p mode frequencies.

Here we present our analysis of the Kepler time series of a set of 25 solar-type stars, which were observed for at least 550 days, each. We divide the time series of each star into shorter sub-series in order to analyse the temporal evolution of the p mode frequencies. The sub-series' periodograms are cross-correlated to retrieve the shift of p mode frequencies. The error on the shifts are estimated by a resampling technique.

We find significant frequency shifts of p modes in a large subset of the investigated 25 stars, which indicate cyclic behaviour. For the most prominent example KIC 8006161, we investigate the shift of p mode frequencies for three distinct ranges of frequencies. We find that, not unlike in the solar case, frequency shifts are smallest for the lowest and largest in the highest p mode frequency range.

P16

M.K. Bensmaïa: Time Dependent Convection astroseismic study of Beta Hydri

Authors: M. K. Bensmaïa, A. Grigahcène, M.-A. Dupret, Y. Damerdji, R. Garrido and R. Mecheri

The subgiant star β Hydri shows solar-like oscillations that allow its study using asteroseismology. In this work we use Time-Dependent Convection (TDC) models to better constrain its structure models and estimate its global parameters using the seismic and non-seismic available data. We obtain several models which match all observable constraints, in particular, our best model reproduces the observed frequencies with an offset less than 3 μHz which is the maximum uncertainty, an unattainable result with a purely adiabatic treatment. Among the 33 reliable modes, our best model reproduces all the frequencies at 2-σ level, among which 21 modes (ie 64%) are within 1-σ error. Finally, this leads us to obtain the following values of the global parameters, for instance a mass of M= 1.06 M_{sun} and age of 7.64 Gyr.

P17

Mutlu Yildiz: Effects of the HeII ionization zones on oscillation frequencies - Applications to Kepler and CoRoT stars

Authors: Mutlu YILDIZ, Zeynep ÇELIK ORHAN, Cenk KAYHAN

In the present study, solar-like oscillation frequencies of 93 target stars of *Kepler* and *CoRoT* are analysed.
Recently, two new reference frequencies (ν_{min1} and ν_{min2}) are found in the spacing of solar-like oscillation frequencies of stellar interior models. In addition to the frequency of maximum amplitude (ν_{max}), these frequencies have very strong diagnostic potential for determination of fundamental properties. Present study deals with application of derived relations from the models to the *Kepler* and *CoRoT* target stars. The most important difference between the model and observational frequencies is in their ordering according to their value. The order in models depend on stellar mass.
In the oscillation frequencies detected by the *Kepler* and *CoRoT* telescopes, however, the order is independent of stellar mass and the mean of minimum frequencies is equal to ν_{max} with a very high precision.

P18

Redoune Mecheri: Modeling the oscillations of a rotating polytropic star

In this contribution we present a new simplified hydrodynamic model for the calculation of the oscillations of a rotating polytropic star. The model consists of a set of first order linear ordinary differential equations representing an eigenvalues problem. Using a surface fitted system of coordinates, the equations can be solved numerically using the appropriate boundary conditions at the center and at the surface of the rotating (non-spherical) star. The polytropic case can serve as a validation test before going to a more realistic (non-polytropic) real star

Projects

P19

Markus Roth: Solarnet Transnational Access Programme 2013 – 2017

Authors: Alberto Escobar, Jesús Burgos, Manuel Collados & The Solarnet Board

As part of the Solarnet project, the Transnational Access and Service Programme supports the access of the European solar physics community to some of the best European solar telescopes. To enhance the efficiency of data usage, external observers will receive also support for post-factum reduction of data, while standard pipelines are not fully developed, with the aim of providing them science-ready data. A successful Programme, which will bring together researchers of different nationalities, forms the basis for a long-term perspective of solar physics in Europe and for the operation of the European Solar Telescope, when it becomes a reality.

P20

Kevin Belkacem & Eric Michel: The Seismic Plus portal

The wealth of seismic data available from space borne missions (SOHO, CoRoT, Kepler, SDO,…), and from ground-based observations (GONG, Bison, ground-based large programmes…), is stimulating solar and stellar structure and evolution studies but is also opening new scientific perspectives (e.g. characterization of planetary systems, stellar population in our galaxy, etc…). These applications address a broad scientific community within and beyond the solar and stellar communities. They require combining data of various types and from various sources.
The Seismic Plus Portal intends to help this increasing use of seismic information by providing, at a well-identified place, a homogeneous description and access for sources of solar and stellar seismic data as well as for sources of complementary and ground-based data.
The Seismic Plus portal is now open and available at
http://voparisspaceinn.obspm.fr/seismicplus/
It is currently being developed in the framework of the SPACEInn project (Exploitation of Space Data for Innovative Helio- and Asteroseismology) financed by the European Union under the Seventh Framework Programme (FP7).
We describe here the opening of the Seismic Plus portal and provide a short description of its main functionalities.

P21

Markus Roth: Exploitation of Space Data for Innovative Helio- and Asteroseismology

Authors: Markus Roth & SpaceInn Board

The European Helio- and Asteroseismology Network (HELAS) has initiated the follow-up project "SpaceInn - Exploitation of Space Data for Innovative Helio- and Asteroseismolgoy" with the mission to build on the existing European strength in the field of time-domain stellar physics. SpaceInn activities, which are organized around the themes of data access, scientific expertise and existing coordination, aim to secure optimal use of the existing and planned data, from space and from the ground, in helio- and asteroseismology. Starting in January 1, 2013, the SpaceInn project is funded for four years by the European Union.
The main goals of the project include:

-Establish coordinated archives of space- and ground-based data, as well as of the results of the analyses of these data. This will include tools for efficient data access.

-Secured long-term preservation of these, often unique, data.

-Coordinated utilization of the data, resulting in a much improved understanding of solar structure, dynamics and activity, as well as of stellar structure and evolution

-An increased awareness of the field, amongst the general public and at all levels of the educational system, throughout Europe.

The main outcome of the project will be a greatly improved understanding of solar and stellar structure, evolution and activity, including also those aspects of the solar activity that have potential societal impacts. Moreover the project aims at extending the use of seismic data to a broader scientific community, beyond solar and stellar physicists.

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