

RESEARCH CONFERENCES

ESF Conference in Partnership with LFUI

The Modern Era of Helio- and Asteroseismology

20-25 May 2012

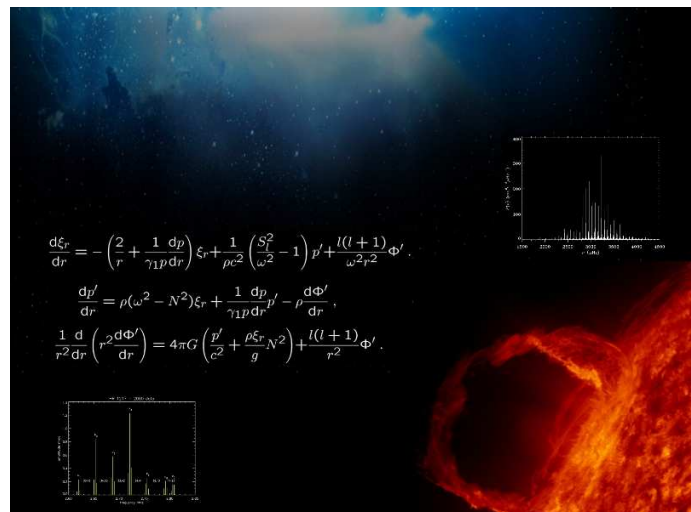
Universitätszentrum Obergurgl, Austria

Chair:

Markus Roth, Kiepenheuer-Institut für Sonnenphysik, DE

Co-chairs:

Katrien Uytterhoeven, Instituto de Astrofísica de Canarias, ES



Conference Highlights

Please provide a brief summary of the conference and its highlights in non-specialist terms (especially for highly technical subjects) for communication and publicity purposes. (ca. 400-500 words)

The ESF Conference “The Modern Era of Helio- and Asteroseismology” was the first conference organized by the European Science Foundation (ESF) in this research area.

Helio- and asteroseismology – the study of the solar and stellar interiors by means of acoustic waves probing these celestial bodies – are rather young scientific areas of astrophysics.

Helioseismology has been tremendously successful in illuminating the physical state of the solar interior during the last decades. Precise measurements of the oscillations of velocity and intensity of the solar surface, covering many years, are carried out with worldwide networks of observing stations as well as dedicated space experiments.

Helioseismology bears the promise to provide essential information about the working of the solar dynamo, which itself causes the 11-year cycle of magnetic activity and therefore ultimately impacts the near-Earth space environment and the Earth’s climate.

Although the Sun serves as a stellar paradigm because of its proximity, stars cover a broad range of physical parameters such as mass, age, angular momentum and chemical composition for which the Sun cannot be representative. Asteroseismology – i.e., deriving information about the interior of stars by observing stellar oscillations – is capable to deliver important fundamental stellar parameters which otherwise would remain inaccessible. Asteroseismology is exceedingly difficult and has only recently produced results, with the advent of very sensitive high-resolution stellar spectrographs.

This conference gave the opportunity to bring these two disciplines together to allow presenting the results and to work on possible synergies.

The conference program was organized such that invited speakers gave overview lectures on the topics: solar and stellar modeling, and seismic results on the Sun and the stars. This was important to train the young generation of scientists present at the conference. The outlook session provided an important view on the needs of this research area where Europe plays a leading role. Special focus was given on theoretical models, data and instrumentation, and the next generation of scientists.

The average age of the participants at the conference was below 36, showing a very vital and young field of research. During session breaks and the poster sessions these young scientists came in close contact with the senior experts in the field.

Most of the conference attendees could be financially supported by covering travel costs and/or the registration fee (which included lodging and food) thanks to the sponsoring of the European Science Foundation, the Leopold-Franzens-University Innsbruck (LFUI), the European Association for Solar Telescopes (EAST), and the European Helio- and Asteroseismology Network (HELAS).

The conference organization and the management by the ESF were complimented from all participants.



I hereby authorize ESF – and the conference partners to use the information contained in the above section on ‘Conference Highlights’ in their communication on the scheme.

Scientific Report

Executive Summary

(2 pages max)

Market situation

Planned financing of the research area

Helioseismology and asteroseismology are the only means to investigate the interior of the Sun and stars. They are crucial for understanding the structure and evolution of stars, which produce all chemical elements in the universe heavier than helium, and which host and influence planets which may carry life. Understanding the physics of the Sun's interior is essential for understanding the solar dynamo and consequently for predicting solar magnetic activity, which has a severe impact on the operation of space missions. Understanding the interior of the stars is essential for understanding those astronomical objects that host and influence planets.

With the suite of the latest instruments and missions, e.g. BiSON, GONG, SOHO, SDO, Hinode and Picard for solar exploration and MOST, CoRoT, Kepler, BRITE, SONG for stellar and exoplanetary research, the precision on the seismically determined quantities, e.g. flows in the solar interior or the ages and radii of stars will be greatly improved.

This will allow creating new knowledge in solar physics and astrophysics and therefore made the proposed conference particularly timely.

Helio- and asteroseismology cover a wide range of disciplines of physics and astrophysics e.g. solar Physics, stellar Physics, stellar structure and evolution, hydrodynamics, magnetohydrodynamics, plasma physics, nuclear physics, particle physics, exo-planetology, space physics, statistical physics, data analysis and modelling, and space weather, to name the most relevant.

In the last 30 years helioseismology has tremendously increased our knowledge about the internal properties of the Sun. Asteroseismology continues this success by investigating the interior of large numbers of individual stars. Precise measurements of the oscillations on the Sun and the stars are carried out with worldwide networks of observing stations and dedicated space experiments. These disciplines allow, e.g. understanding the structure and evolution of stars, the production of chemical elements in the universe, and the origin of the Sun's magnetic field and its effects on space weather. With its many interdisciplinary links to other research areas, e.g. plasma physics, nuclear and particle physics, formation and evolution of planetary systems and galaxies, or solar system and space physics, helio- and asteroseismology are a major part of the European astrophysical community and are very attractive to many young scientists in the European Research Area.

European research is strongly reflected in the areas of helio- and asteroseismology. Helio- and asteroseismology are exciting and active branches of solar physics and astrophysics. Europe hosts more than 200 scientists which are active in helio- and/or asteroseismology and plays a major role worldwide. It shall be noted that most of these researchers are below 36 and in its early stages of their scientific careers.

The studies of the constitution and internal processes of the Sun and the stars by helio- and asteroseismology are carried out worldwide. The USA operates important instruments, e.g. the

observing stations of the Global Oscillation Network Group (GONG; in operation since 1995) the Michelson Doppler Imager (MDI) aboard the NASA space mission Solar and Heliospheric Observatory (SOHO; in operation since 2006) and the Solar Dynamics Observatory (SDO; in operation since 2010). In Europe the Birmingham Solar Oscillation Network (BiSON) records the global solar oscillations, and the Stellar Observation Network Group (SONG) is about to install its first prototype on Tenerife to observe stellar oscillations. In addition Europe plays an important role in the preparation of the Solar Orbiter space mission. Another solar mission is under preparation in Japan: Solar-C might be launched within this decade as follow-up mission to the successful Japanese Hinode (Solar-B) solar space observatory.

Other important missions for observing stellar oscillations are the CNES mission CoRoT (Convection, Rotation and Transits), and the NASA mission Kepler, which will help understanding stars and planetary systems much better.

It is worthwhile to note here again, that besides the active participation in the milestone missions of the field, Europe hosts a large fraction of the scientists that make use of the data delivered by these instruments.

In 2006 the European Helio- and Asteroseismology Network (HELAS, www.helas-eu.org) was established, which received funding as coordination action from April 6, 2006 until March 31, 2010 under the European Commission's Sixth Framework Programme (FP6).

HELAS coordinates the activities in Europe in these research areas and maintains strong contacts to the research groups overseas.

In the last years the productivity and publication rate in these fields have markedly increased. The new asteroseismology space missions, e.g. SDO, CoRoT and Kepler, have a strong influence on generating new knowledge on the processes inside the Sun and the stars. Therefore, helioseismology has won on importance, especially for studying the origins of the solar dynamo. With the continuous influx of data from space and the advent of the latest space missions (e.g. Solar Orbiter) this increase in productivity is expected to continue further.

In Europe the new collaborative project SPACEINN, which is funded by the European Commission from 2012-2016 will allow to fully exploit these data from ground and space in form of a community effort.

Scientific Content of the Conference

(1 page min.)

- Summary of the conference sessions focusing on the scientific highlights
- Assessment of the results and their potential impact on future research or applications

Monday, May 21, 2012

Session I - Global Helio- and Asteroseismology:

This session concentrated mainly on the theoretical aspects of probing global physical properties of the Sun and the stars by helio- and asteroseismology.

The highlights of this session were the presented prospects of the three-dimensional modeling of convection and the radiative transfer of energy that produces the stellar spectra to arrive at more precise models of the Sun and the stars.

Tuesday, May 22, 2012

Session II: Seismic inferences on the properties of the Sun and the stars:

The main topics of the second session were the inferences obtained on solar and stellar interior physics by helio- and asteroseismic methods. Thanks to the Solar Dynamics Observatory (SDO) flows inside the Sun can now be studied with great precision. And thanks to the wealth of data delivered by CoRoT and Kepler stellar interiors are now accessible for seismic methods.

Wednesday, May 23, 2012

Session III: Solar and stellar activity:

Given the possibility to measure flows inside the Sun the root causes of Sun's magnetic activity can be studied by helioseismology. Also models of sunspots can now be tested against seismic constraints.

Also other stars than the Sun show magnetic activity. Due to seismic methods their structure and internal rotation are accessible allowing studying a large parameter range in which stellar dynamos are working.

Forward Look

(1 page min.)

- *Assessment of the results*
- *Contribution to the future direction of the field – identification of issues in the 5-10 years & timeframe*
- *Identification of emerging topics*

The forward looking session covered the full day of Thursday, May 24, 2012. Three discussion sessions were organized:

Session I: The next generation of instruments for helio- and asteroseismology

Helio- and asteroseismology have the need to record uninterrupted time series of solar and stellar oscillations for a long time. On the ground the Global Oscillation Network Group (GONG) and the Birmingham Solar Oscillation Network (BiSON) deliver helioseismic data for more than one solar sunspot cycle. Continuing this time series would allow understanding not only the Sun's eleven-year magnetic cycle but also understanding the long-term variation of solar activity over decades.

Space missions such as Corot and Kepler have been invaluable for the development of asteroseismology and it is essential that this research area is considered in the design and downselection of future missions.

Session II: The next generation of solar and stellar modelling - which theories are needed

Modelling of solar and stellar structure as well as the interaction of seismic waves with flows and magnetic fields inside the sun and in sunspots are important tools to tailor seismic tools. Much of collaboration will be needed to further develop the existing numerical codes and to resolve currently open questions, e.g. the only low metallicities needed to model stellar spectra and the discrepancies that this causes between helioseismic and stellar structure models.

Session II: Career Opportunities in Europe

As Europe currently sees a strong increase in young scientists working in helio- and

asteroseismology, part of the forward-looking discussion was devoted to discuss who would be the next generation of scientists in Europe.

In this session all possibilities to apply for the funding of the own position for each European country as well as regular calls, e.g. Marie Curie Actions, ERC calls to support live-long training and career development in Europe were reviewed.

In addition large European initiatives that will be supported by the European Commission's FP7 programme were presented, i.e. SPACEINN and SOLARNET.

▪ Is there a need for a foresight-type initiative?

It would be very important to allow this community to meet again in two years time. Many new missions for helio- and asteroseismology have just recently been commissioned and deliver a large amount of data in unheard volume of, which will produce new scientific results. Furthermore the scientific productivity of this community will profit by the possibility to deepen the interaction and collaborations initiated at this conference.

Atmosphere and Infrastructure

▪ *The reaction of the participants to the location and the organization, including networking, and any other relevant comments*

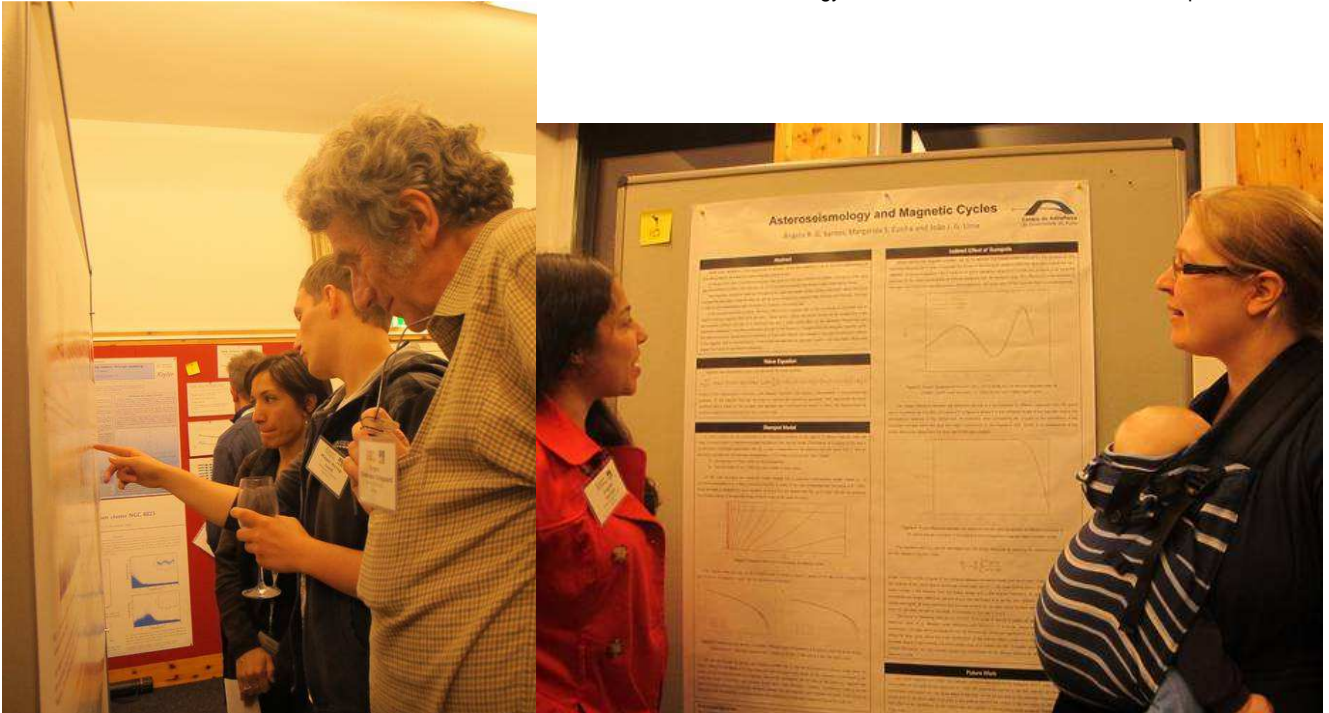
The University of Innsbruck Conference Center in Obergurgl provided an ideal setting for this conference. The joint housing of almost all participants in the same building, the possibility of joint lunches and dinners, and the possibility for discussions and scientific interaction also after the conference session generated an inspiring atmosphere.

The equipment of the venue was adequate to satisfy the needs of this conference.

All participants congratulated the conference chairs for the successful organization of the conference. Being prepared for all eventualities, e.g. child care to allow young mothers to participate at the conference, and the overall excellent organization by the conference officer was highlighted in the feedback from the participants.



Group picture of the conference participants taken outside the University of Innsbruck conference center Obergurgl.



Junior and senior scientists during an evening poster session.

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Date & Author:

September 24, 2012 Markus Roth