

HELAS – EUROPEAN HELIO- AND ASTEROSEISMOLOGY NETWORK

M. Roth¹, O. v.d. Lühe², P. Pallé³, M. Thompson⁴, J. Christensen-Dalsgaard⁵, M.J.P.F.G. Monteiro⁶, L. Gizon⁷,
M.P. Di Mauro⁸, C. Aerts⁹, J. Daszynska-Daszkiewicz¹⁰, and T. Corbard¹¹

¹Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau, Germany

²Kiepenheuer-Institut für Sonnenphysik, 79104 Freiburg, Germany

³Instituto de Astrofísica de Canarias, E38200 – La Laguna (Tenerife), Spain

⁴Department of Applied Mathematics, University of Sheffield, Sheffield S3 7RH, U.K.

⁵Institut for Fysik og Astronomi, Aarhus Universitet, DK-8000 Aarhus C, Denmark

⁶Centro de Astrofísica da Universidade do Porto, 4150-762 Porto, Portugal

⁷Max-Planck-Institut für Sonnensystemforschung, 37191 Katlenburg-Lindau, Germany

⁸Istituto Nazionale di Astrofisica, I-00133 Roma, Italy

⁹Instituut voor Sterrenkunde, Katholieke Universiteit Leuven, B-3001 Leuven, Belgium

¹⁰Instytut Astronomiczny – Uniwersytet Wrocławski, Pl-51-622 Wrocław, Poland

¹¹Observatoire de Côte d’Azur, F-06304 Nice Cedex 04, France

ABSTRACT

The Helio- and Asteroseismology Network (HELAS) is a Coordinated Action funded by the FP6-Infrastructure-Programme of the European Commission. Currently, HELAS consists of ten members. The objective of HELAS is to co-ordinate European activities in helio- and asteroseismology. HELAS will transfer knowledge and data analysis techniques, and will prepare the European research community for important missions in the immediate future.



Figure 1. The logo of the European Helio- and Asteroseismology Network (HELAS).

1. HELAS

The funding of HELAS under the the Sixth Framework Programme of the European Union started at April 1, 2006 and will last until March 31, 2010. Its major objective is to bring together European research groups active in helio- and asteroseismology. Currently HELAS consists of ten members which are listed in Section 3. Moreover HELAS will embed many of the activities of the European Network of Excellence in Asteroseismology (ENEAS). HELAS will combine the core competences of the individual research groups through six network activities in order to ensure European competence and competitiveness in this research area by spreading expertise, enhancing the synergy between helio- and asteroseismology, and improving the public understanding and interest in solar and stellar physics. These objectives shall be achieved by organizing workshops of smaller group within the individual network activities, by organising annual conferences for the international audience, and by providing a common platform for the exchange of data and software among the participants.

The start of HELAS comes quite timely as many new missions and chances for helio- and asteroseismology are ahead, e.g. the NASA space mission Solar Dynamics Observatory (SDO), the CNES missions COROT (Convection, Rotation & planetary Transits) and PICARD, the ESA mission Solar Orbiter, and GOLF-NG (Global Oscillations at Low Frequencies New Generation). These new projects require networking in order to prepare the European helio- and asteroseismology community to the advent of the data from these missions.

2. NETWORK ACTIVITIES

1. **Management** – The first activity concerns the overall coordination and management of the consortium, the setting of the strategies, the financial management, and the liaison with the European Union.
Coordinator: Oskar von der Lühe,

Project Scientist: Markus Roth.

2. **HELAS Forum** – The HELAS Forum serves as platform for discussing all network activities of HELAS and developing the plans of mutual interest. Once in a year an international meeting is organized. Moreover the HELAS Forum will generate and exploit synergies between other networks. An internet portal will allow to exchange and distribute software and data.

Chair: Pere Pallé.

3. **Global Helioseismology** – This network activity is devoted to the elicitation of new exigent problems and the coordination of the methods and software developments for global helioseismology. Data analysis tools and solar models in the HELAS community will be distributed.

Chair: Mike Thompson.

4. **Local Helioseismology** – The fourth network activity concentrates on local helioseismology. There it is necessary to identify the needs and to develop actions for structuring research in the field of local helioseismology. The development and distribution of specific software will be coordinated in order to provide Europe with the means to participate in the analysis and interpretation of HMI-SDO data.

Chair: Laurent Gizon.

5. **Asteroseismology** – The fifth network activity develops programmes to ensure European competitiveness on the field of asteroseismology. This comprises comparisons of model and frequency calculations in order to improve their reliability. Furthermore the developments of stellar modelling software will be coordinated and its results distributed within the HELAS community.

Chair: Conny Aerts.

6. **Public Outreach** – The major objectives of the public outreach in HELAS will be the preparation of state-of-the-art university lectures and the coordination of actions on the field of helio- and asteroseismology to raise public interest.

Chair: Jørgen Christensen-Dalsgaard.

3. HELAS MEMBERS

HELAS shall become an important contact point for the European groups active in helio- and asteroseismology. Consequently, it is expected that the number of HELAS members will grow. At the start date of funding – April 1, 2006 – HELAS consisted of ten members:

1.) Kiepenheuer-Institut für Sonnenphysik
Schöneckstr. 6-7
79104 Freiburg, Germany
<http://www.kis.uni-freiburg.de/>
Contact: Prof. Oskar von der Lühe
Tel.: +49 761 3198 0
Fax: +49 761 3198 111
E-mail: secr@kis.uni-freiburg.de

The Kiepenheuer-Institut für Sonnenphysik (KIS), a member of the Leibniz association, is the largest German institute specialized in solar physics. The institute operates the German solar telescopes at the Observatorio del Teide, Tenerife, and leads the construction of the 1.5m solar telescope GREGOR. It participates in several international instrumentation projects for the ground and space. The number of employees (scientific, technical and administration) is about 55. The research at the KIS is focused on the observational and theoretical description of the magnetic solar activity. The KIS has a long-standing history in helioseismology, dating back to the pioneering work of Franz-Ludwig Deubner, who detected the standing wave character of the "five-minute oscillations". Currently, the helioseismic research at the KIS is concentrated on the development of new techniques for inferring information on the origin of the solar activity. This includes studies of the solar interior dynamics and their temporal variation.

2.) Instituto de Astrofísica de Canarias
C/ Vía Láctea, s/n
E38200 - La Laguna (Tenerife). España
Contact: Pere L. Pallé
<http://www.iac.es>
Tel: +34 / 922 605 200
Fax: +34 / 922 605 210
E-mail: pere.l.palle@iac.es

The Instituto de Astrofísica de Canarias (IAC) is a highly internationalized research centre comprising the Instituto de Astrofísica, as the Headquarters in La Laguna; the La Palma Centre of Astrophysics and Teide and Roque de los Muchachos Observatories. The IAC Helio- and Asteroseismology Group consists of 13 members (6 staff, 2 postdocs and 4 PhD students) and is responsible for the "SolarLab" at the Observatorio del Teide, the only site hosting devoted instrumentation belonging to all existing ground-based helioseismology networks (GONG, BiSON, TON, ECHO), some major coordinated asteroseismology experiments (STARE) and multi-site campaigns (STEPHI). The team has been involved in those projects at observing, interpretation and scientific exploitation levels, and therefore acquired a unique expertise. Furthermore, the IAC Team has been involved as partner consortium in the construction, operation, and scientific exploitation of two European experiments aboard SoHO (GOLF and LOI/VIRGO) and it is involved in the COROT mission.

3.) Department of Applied Mathematics
University of Sheffield
Hicks Building
Hounsfield Road
Sheffield S3 7RH, U.K.
<http://www.shef.ac.uk/>
Contact: Prof. Michael J. Thompson
Tel.: +44 (0)114 222 3733
Fax: +44 (0)114 222 3739
E-mail: Michael.Thompson@sheffield.ac.uk

The University of Sheffield node of HELAS is led by

Michael Thompson. The Sheffield team has extensive experience in inversion of global and local helioseismic data to study the internal structure and dynamics of the Sun. It is currently developing inverse techniques for asteroseismic data and grid-based technologies for exploiting the forthcoming helioseismic observations from the Solar Dynamics Observatory satellite. It has a strong track record of training research students and postdoctoral researchers. The team's particular strengths are in helioseismic and asteroseismic modelling and inversion, and in modelling the effects of magnetic fields on solar oscillations.

4.) Institut for Fysik og Astronomi, Aarhus Universitet
Ny Munkegade, Bygn. 1520
DK-8000 Århus C, Denmark
<http://astro.phys.au.dk/>
Contact: Jrgen Christensen-Dalsgaard
Tel: +45 8942 3614
Fax: +45 8612 0740
E-mail: jcd@phys.au.dk

The Aarhus team is part of the Department of Physics and Astronomy, with a total scientific staff of around 59, and consists of three permanent staff members, two postdocs and one PhD student. The Aarhus group has a long history in the use of helioseismic techniques to determine solar internal structure and rotation, including investigations of the equation of state and opacity. Great emphasis has been placed on the development of reliable techniques for computing stellar models. The team has been leading in ground-based observations of solar-like oscillations in other stars. A recent important contribution has been the study of oscillations in the A and B components of the alpha Centauri binary system. The theoretical activities of the team now also emphasize asteroseismology, including the development of techniques for fitting or inverting stellar oscillation data. The team will take part in the COROT and the NASA Kepler missions, in the latter case with prime responsibility for the interpretation of the asteroseismic data. The IFA team has made substantial contributions to public outreach, including the organization of planetarium shows in collaboration with the local planetaria.

5.) CENTRO DE ASTROFISICA Universidade do Porto
Rua das Estrelas
P-4150-762 Porto, Portugal
<http://www.astro.up.pt/>
Contact: Mario Joao P. F. G. Monteiro
Tel: +351 - 226 089 830/857
Fax: +351 - 226 089 831
E-mail: mjm@astro.up.pt

CAUP is the largest institute for Astronomy in Portugal with a team of about 20 researchers and over 40 postgraduate students working on two broad areas: Stellar Astrophysics and Cosmology. It hosts several postgraduate programmes in Astronomy and provides support to the undergraduate degree in Astronomy in the University of Porto. CAUP participates in several European Consortia funded by the European Commission. The Stellar

Structure and Evolution team at CAUP includes four senior researchers and several PhD students, that participate in Asteroseismology (COROT and MOST) and helioseismology (SOHO) missions. The team's expertise centers on the seismic analysis of the Sun and other solar-type and intermediate mass stars, from the pre-main sequence up to more advanced stages of evolution. The research focuses on the seismic study of convection and overshoot, chemical composition, stellar modelling and magnetic effects on the frequencies, as well as the seismic study of the Sun, solar-type stars, roAp stars, and pre-main sequence low-mass stars.

6.) Max-Planck-Institut für Sonnensystemforschung
Max-Planck-Strasse 2
37191 Katlenburg-Lindau, Germany
<http://www.mps.mpg.de/en/index.html>
Contact: Laurent Gizon
TEL: +49 (0)5556 979-439 (Office) / -299 (Secr.)
FAX: +49 (0)5556 979-240
E-mail: gizon@mps.mpg.de

The Max Planck Institute for Solar System Research (MPS) is one of 78 institutes and research facilities maintained by the Max Planck Society across Germany. Scientific work at the MPS can be split into three major fields of research: The Sun and heliosphere, planets and comets, and magnetospheres. The solar research group has extensive experience in observations of photospheric magnetism, studies of solar variability and climate, numerical modelling of solar convection, and dynamo theory. A new independent research group in solar and stellar seismology was created in 2005. An essential part of the Institute's activities is the development and construction of instrumentation for space missions. The institute has played a leading role in about 80 successful space missions since 1965, including Helios, Giotto, Cluster, SOHO, Mars Pathfinder, Cassini, and Rosetta, to mention a few of the most significant.

7.) INAF-IASF Roma
Via del Fosso del Cavaliere, 100
I-00133 Roma, Italy
Contact: Maria Pia Di Mauro
Tel.: +39 06 4993 ext 4658
Fax: +39-0620660188
E-mail: mariapia.dimauro@iasf-roma.inaf.it

The asteroseismology group of the INAF (Istituto Nazionale di Astrofisica – National Institute for Astrophysics) consists of several institutes of astrophysics in Italy. The team was established in 2001 with the idea to gather people with complementary skills in studies of helio- and asteroseismology. The group is involved in the study of stellar variability with regards to photometric and spectroscopic observations and data analysis, particularly of solar-type, delta Scuti, gamma Doradus, sdB stars and white dwarfs. The theoretical work focuses on expertises in the interpretation of the oscillations spectrum of the Sun and solar-like stars, by including effects such as rotation and overshoot from convective zones. The group is involved in the application and development of helio-

seismic inversions techniques useful to unveil solar and stellar internal regions. The team has developed a stellar evolution code with the aim to study the internal structure of the stars in various phases of their evolution.

8.) Instituut voor Sterrenkunde
Departement Natuurkunde en Sterrenkunde
Katholieke Universiteit Leuven
Celestijnenlaan 200 B
B - 3001 Leuven, Belgium
<http://www.ster.kuleuven.be>
Contact: Conny Aerts
Tel: +32/16/32 70 28
Fax: +32/16/32 79 99
E-mail: conny@ster.kuleuven.be

The Institute of Astronomy of Leuven University contains a large gender-balanced and diverse team in asteroseismology, composed of 8 PhD students, 6 postdocs, 1 software engineer and 1 staff member. This team has a long tradition in observational studies of heat-driven oscillation modes of main sequence stars, from the cool F-type Gamma Doradus stars up to the hot massive B-type Beta Cephei stars. It has recently also been heavily involved in the discovery of stochastically-excited oscillation modes in solar-like stars and in red giants. Specific expertise includes development and application of methodology for empirical mode identification from multicolour photometry and from high-resolution line-profile variations. Two of the team members are co-Investigator of the CoRoT space mission, with responsibilities on B-type pulsators and red giants respectively. The team is also involved in the automated classification of variable stars from light curves in the framework of the CoRoT and Gaia space missions.

9.) Instytut Astronomiczny, Uniwersytet Wrocławski
ul. Kopernika 11,
Pl-51-622 Wrocław, Poland
<http://www.astro.uni.wroc.pl>
Contact: Jadwiga Daszynska
Tel: +48 71 37 29 373
Fax: +48 71 37 29 378
E-mail: daszynska@astro.uni.wroc.pl

The Wrocław Institute hosts experts in observations as well as in the theory of pulsating stars, in a strong collaboration with astronomers from Warsaw. The group consists of nine permanent staff members and two PhD students. The research concentrates on the search for B-type variables in young open clusters, particularly for beta Cep, SPB, Be and sdB stars. To this end, multicolour photometry is carried out, and data from the MACHO and OGLE projects are analyzed. One of the main results of these studies is the discovery of the first beta Cep and SPB stars in Magellanic Clouds. Stellar parameters and metallicities are determined using spectra from the ground-based observations and from space missions. The theoretical work focuses on modelling of stellar evolution and non-adiabatic pulsations. The Warsaw-Wrocław team developed the method of non-adiabatic photometric observables for the mode identification. Moreover, the

team invented another method, which, besides the mode identification, yields a new asteroseismic probe giving constraints on stellar parameters, convection, chemical composition and atomic data (opacity).

10.) Observatoire de la Côte d'Azur
Bd. de l'Observatoire
B.P. 4229
F-06304 Nice Cedex 04 France
<http://www.obs-nice.fr/>
Contact: Thierry Corbard
Tel: +33 (0)492003011
Fax: +33 (0)492003033
E-mail: Thierry.CORBARD@obs-nice.fr

The Côte d'Azur Observatory (OCA) is ruled under the French education ministry in partnership with CNRS (Centre National de la Recherche Scientifique) and has close relationship with Nice University where several researchers are also teaching. It is made of about 200 people working in three scientific departments. The solar and stellar physic group of OCA has been leaders in the earliest development of ground based and spatial helioseismology. They are now involved as co-investigators in the CNES PICARD micro-satellite mission for solar shape measurements and in the CNES/ESA asteroseismic mission COROT. They are also contributing in developing local helioseismology methods for studying notably the meridional circulation and the correlation between sub-surface dynamics and magnetic activity. Theoretical studies include models of stellar evolution, stellar structure and pulsation, solar turbulence, MHD, dynamo theories and photospheric magnetism.

4. CONTACTS

The European Helio- and Asteroseismology Network can be contacted at:

HELAS Project Office
Kiepenheuer-Institut für Sonnenphysik
Schöneckstr. 6
79104 Freiburg / Germany
Tel.: ++49-761-3198-0
WWW: <http://helas.kis.uni-freiburg.de>
e-Mail: roth@mps.mpg.de