

EUROPEAN HELIO- AND ASTEROSEISMOLOGY NETWORK – HELAS

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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.

1. HELAS

The European Helio- and Asteroseismology Network – HELAS – has as its major objective bringing together the widely dispersed European research groups active in helio- and asteroseismology. HELAS will combine the core expertise of the individual research groups through six network activities listed in Section 2 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 groups within the individual network activities, by organizing annual conferences for the international audience, and by providing a common platform for the exchange of data and software among the participants.

The transfer of knowledge and data analysis techniques through HELAS shall lead to a structuring of this field of research, as needed to prepare the European research community for important missions in the

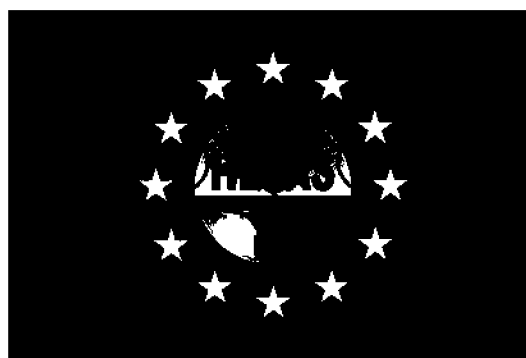


Figure 1. The logo of the European Helio- and Asteroseismology Network (HELAS).

near future: the NASA space missions Solar Dynamics Observatory (SDO) and Kepler, the CNES missions CoRoT and PICARD, the ESA mission Solar Orbiter, the French/Spanish mission GOLF-NG, as well as ongoing and planned ground-based initiatives.

The funding of HELAS started on April 1, 2006 under the Sixth Framework Programme of the European Union and will last until March 31, 2010. HELAS receives a grant of 2.265.000 EURO.

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).

2. NETWORK ACTIVITIES

HELAS itself is not able to fund research and development. The major activity of HELAS is to contribute to the coordination of activities by supporting the interaction of scientists.

1. **Management** – The first activity handles the overall coordination and management of the consortium, the setting of the strategies, the financial management, and the interaction with the European Commission.

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 a year an international conference is organized. The plan for these annual events is laid out in Table 1

Moreover the HELAS Forum will generate and exploit synergies between the network activities. An internet portal will allow the exchange and distribution of software and data. The internet portal will be accessible at: <http://www.helas-eu.org>

Chair: Pere Pallé, IAC.

3. **Global Helioseismology** – This network activity is devoted to the elicitation of new and 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. To coordinate the activities in global helioseismology three workshops will be held on the topics

- Low frequency spectral range
- Solar-cycle variations and magnetic effects on stellar oscillations
- New insights into the Sun.

Chair: Mike Thompson, UoS.

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. Three workshops will be held on the topics:

- Roadmap for local helioseismology
- Local helioseismology and solar MHD processes
- Local helioseismology with SDO data.

Chair: Laurent Gizon, MPS.

5. **Asteroseismology** – The fifth network activity develops programmes to ensure European competitiveness in 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.

Four workshops will be held on the topics:

- Future plans for ground-based and space observations for asteroseismology
- Comparison and tests of stellar evolution codes
- Interpretation of asteroseismic data
- Synergies between solar and stellar modelling.

Chair: Conny Aerts, IvS.

6. **Public Outreach** – The major objectives of the public outreach in HELAS is the coordination of actions to raise awareness and interest in helio- and asteroseismology in the general public and at all levels of the educational system throughout Europe. This includes the preparation of state-of-the-art university lectures and other material for further outreach.

Chair: Jørgen Christensen-Dalsgaard, IFA.

3. HELAS MEMBERS

HELAS shall become an important contact point for the European groups active in helio- and asteroseismology. It is an integrative activity. Consequently, it is expected that the activities are not limited to the institutions directly taking part in the network and that the number of HELAS members will grow. At the start date of funding – April 1, 2006 – HELAS consisted of the following ten members:

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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

	Conference Title	Location	Date
(1)	SOHO-18 / GONG 2006 / HELAS-I Beyond the Spherical Sun	Sheffield, Great Britain	August 7 –11, 2006
(2)	HELAS-II Helioseismology, Asteroseismology and MHD Connections	Göttingen, Germany	August 20 – 24, 2007
(3)	HELAS-III COROT-Conference	Paris-Meudon, France	August 2008
(4)	HELAS-IV Four Years of HELAS	Tenerife, Spain	Summer 2009

Table 1. Plan for the annual international HELAS symposia. Title, location and date are given, where these are still preliminary for the years 2008 and 2009.

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.

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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 consist 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 the observing, interpretation and scientific levels, and therefore has acquired a unique expertise. Furthermore, the IAC Team has been involved as a 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.

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The University of Sheffield (UoS) 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.

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The Aarhus team (IFA) 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 a leader 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.

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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.

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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 stel-

lar 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.

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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 helioseismic 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.

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The Institute of Astronomy of Leuven University (IVS) 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.

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The Wrocław Institute (IAUWr) 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, multi-colour photometry is carried out, and data from the MA-CHO 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).

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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 physics group of OCA has been a leader in the earliest development of ground based and spatial helioseismology. The team members are now involved as co-investigators in the CNES PICARD microsatellite 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 tur-

bulence, MHD, dynamo theories and photospheric magnetism.

4. CONTACTS

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

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