# European Helio- and Asteroseismology Network




## 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 the following members:

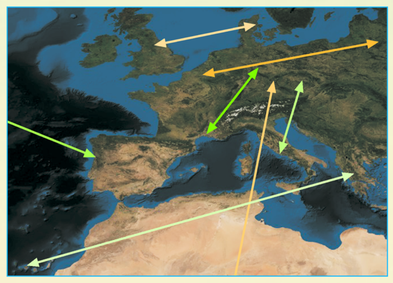
- Kiepenheuer-Institut für Sonnenphysik, Deutschland (Germany) - Network Co-ordinator
- Instituto de Astrofísica de Canarias, España (Spain)
- University of Sheffield, United Kingdom
- Institut for Fysik og Astronomi, Danmark (Denmark)
- Centro de Astrofísica da Universidade do Porto, Portugal
- Max-Planck Institut für Sonnensystemforschung, Deutschland (Germany)
- Istituto Nazionale di Astrofisica, Italia (Italy)
- Instituut voor Sterrenkunde - Katholieke Universiteit Leuven, België (Belgium)
- Instytut Astronomiczny Uniwersytet Wrocławski, Polska (Poland)
- Observatoire de Côte d'Azur, France

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, e.g. the NASA space mission Solar Dynamics Observatory (SDO), the CNES missions CoRoT (Convection,Rotation & planetary Transits) and PICARD, and the ESA mission Solar Orbiter.

Moreover, HELAS will embed many of the activities of the European Network of Excellence in Asteroseismology (ENEAS), and will help organizing coordinated asteroseismic observations.

HELAS will combine the core competences of the individual research groups through its six network activities in order to ensure European competence and competiviness in this research area by spreading expertise, enhance the synergy between helio- and asteroseismology, improve 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.

### NA1 - "Management of CA"

Overall coordination and management of the consortium, liaison with the European Community and international research community, project and budget management.

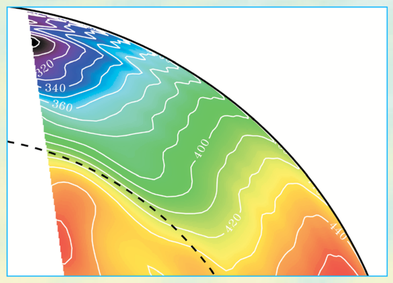
Participants:
All (Chair - KIS)

HELAS Project Scientist: Markus Roth (roth@mps.mpg.de)

### NA2 - "HELAS Forum"

Organization of annual international meetings on helio- and asteroseismology. Provide a forum for discussing all network activities of HELAS and the developments of plans of mutual interest. Generate and exploit synergies between the other networks. Distribution of software and data.

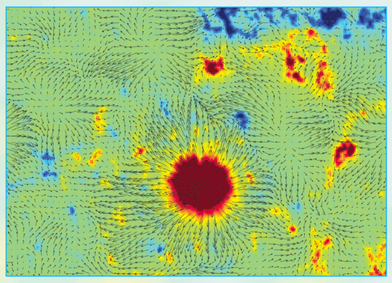
Participants:
All (Chair - IAC)




### NA3 - "Global Helioseismology"

Elicitation of new exigent problems and coordination of the methods and software developments for global helioseismology; distribution of data analysis tools and solar models in the HELAS community.

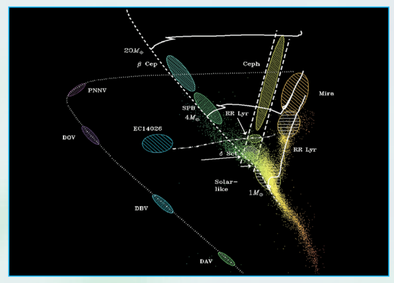
Participants:
KIS, IAC, UoS (Chair), IFA, CAUP, MPS, INAF, OCA



### NA4 -"Local Helioseismology"

The general aim is to make three-dimensional images of the solar interior. Amoung the objectives are coordinate and consolidate European research activities, make available data sets for analysis and comparisons, coordinate the development of software tools, and facilitate the preparation for future space missions (in particular SDO and Solar Orbiter).

Participants:
KIS, IAC, UoS, IFA, MPS (Chair), OCA




### NA5 - "Asteroseismology"

Develop programmes to ensure European competiveness on the field of asteroseismology. Comparisons of model and frequency calculations, to improve their reliability. Coordinate stellar modelling software developments and distribution in the HELAS community.

Participants:
All (Chair - IvS)

### NA6 - "Public Outreach"

Coordinate actions to raise awareness and interest in helio- and asteroseismology in the general public and at all levels of the educational system throughout Europe, including the production of state-of-the art university lectures and other material to further outreach.

Participants:
All (Chair - IFA)

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The University Of Sheffield.

The University of Sheffield node of HELAS is led by Michael J. 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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Centro de Astrofísica da Universidade do Porto

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 centres 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, applied to the seismic study of the Sun, solar-type stars, roAp stars, and pre-main sequence low-mass stars.

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INSTITUTO DE ASTROFISICA DE CANARIAS · IAC ·

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 Asteroseimology 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 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.

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SOLIDUM PETIT IN PROFUNDIS · UNIVERSITAS ARHUSIENSIS ·

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.

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KATHOLIEKE UNIVERSITEIT LEUVEN

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.

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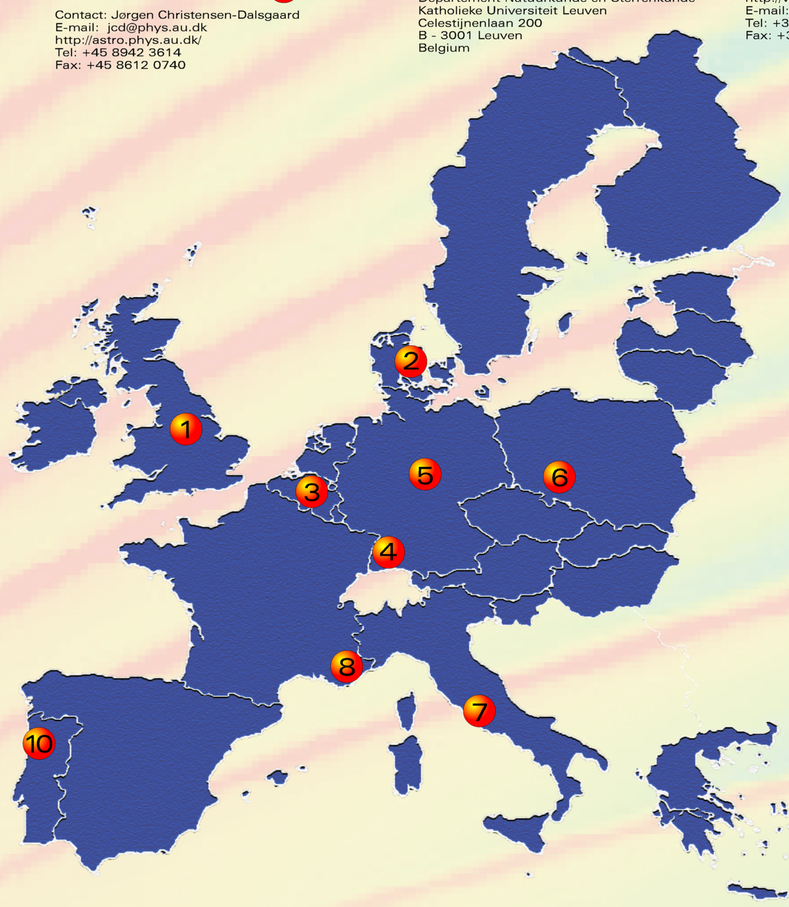


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Observatoire de la Côte d'Azur

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.

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INAF ISTITUTO NAZIONALE DI ASTROFISICA

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 astero-seismology. 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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KIS

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

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MPS

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.

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UNIVERSITAS WRATISLAVIENSIS

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 result 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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