European Astronomical Society
NEWSLETTER
Issue 32. December 2006

Contents

Editorial

Following the trend we started in the previous newsletter, in the current issue we include a few articles on the status of four solar astronomy space missions: SOHO, Ulysses, CORONAS-F, and STEREO. The goal of this type of articles is to inform the European astronomical community not only on the exciting results these missions have produced but also on the science opportunities that will become available in the future. In the following newsletters we will present similar articles on other focused topics and large-scale facilities of broad scientific impact.

The future of the European Astronomy will also be discussed in a Symposium organized by ASTRONET on 23-25 January 2007 at Poitiers, France. As is discussed in the relevant article on the present issue the vision of ASTRONET is to reinforce the position of Europe as a front-line player in astronomy well into the 21st century. Hopefully many astronomers will attend this meeting and will be interested to invest some of their time any energy in this effort.

Vassilis Charmandaris
University of Crete, Greece

Message from the President

This year the biannual elections of part of the EAS Council members took place. The new EAS councilors took up their office after the EAS General Assembly on Monday, August 21, in Prague. I was elected as new President for the next four years and in my first message I would like to thank the EAS members for their confidence in me. It makes me proud of being the follower of our distinguished colleagues Lo Woltjer. Paul Murdin, Jean-Paul Zahn, and Harvey Butcher. For the next four years I shall try with all my strength to keep EAS on a good course for European astronomy.

I would like to thank for their services those colleagues who left office after four or more years on the EAS Council: Harvey Butcher, my predecessor as president, who steered EAS through the past five years, Birgitta Nordström, the Treasurer who kept the finances of EAS in good shape for more than ten years, Councillor Michel Dennefeld who is continuing to work for the EAS as webmaster, Vice-president Cesare Chiosi and Councillor Odbjörn Engvold.

For the next two years the EAS Council has the following members: President: J. Krautter, (Germany), Vice-Presidents: T. Courvoisier (Switzerland), Y. Yatskiv (Ukraine), Secretary: E. Brinks (United Kingdom), Treasurer: A. Dutrey (France), Councilors: A. Gimenez (Spain), E. Oliva (Italy), S. Schindler (Austria), A. Stepanov (Russia), M. Tsvetkov (Bulgaria).

In its 17 years of existence the EAS has established itself in Europe. However, it still does not have the visibility and the acceptance among European astronomers it should have. With well over 5000 astronomers the European community is arguably the largest in the world, but less than 1000 of them are actually members of the EAS!

Necessarily, due to the low membership level and due to the fact that far less than half oft the EAS members actually pay the full membership fee, the finances of the EAS, while being in a very stable condition, do presently not allow to accomplish big tasks. Council hopes that the moderate increase of the reduced membership fees which was recently agreed upon will somewhat alleviate the financial situation.

Certainly, one of the most urgent goals of the new Council has to be to considerably increase the number of EAS members. Council is aware that in our world people only join a society if there is a perceived benefit. So let me give you an outlook to some of our plans for the next years and the tasks we wish to perform.

One of the main goals of the EAS is to promote and to further communication across Europe. As my predecessor wrote in one of his messages, very often projects carried out overseas, in the US, Chile or Hawaii, are better known than those of a neighboring country! A major forum to enhance communication and to improve the flow of information across the community are the JENAMs, the Joint European and National Astronomy Meetings, which are held together with one of EAS's Affiliated Societies. JENAMs have, with the exception of this year, when EAS activities were scheduled alongside the IAU General Assembly in Prague, taken place annually at various places well distributed all over Europe, from Moscow to Porto, from Edinburgh to Catania, and at many more places in between. JENAMs offer the opportunity for European astronomers to get together, to discuss scientific problems, to make new contacts or to refresh old ones. Upon invitation of the Armenian Astronomical Society, the next JENAM will take place in August 2007 in Yerevan in Armenia. An exciting program is awaiting us: we will have a total of eight EAS Symposia and several Special Sessions which cover topical issues, review talks presented by distinguished colleagues, and several highlight talks which will give young colleagues the opportunity to present their research to a plenary audience. In addition, EAS plans to hold a Job Market which should give young researches looking for a position the opportunity to gather information and to establish contacts. Of course, JENAMs will be continued in future; as they evolve, they will remain one of the main activities of the EAS.

Very important tools for enhancing the flow of information are the EAS Newsletter which offers twice a year a wealth of articles on all kinds of topical subjects pertaining to European astronomy, the EAS webpage, and the EAS messages which are distributed via email to EAS members.

As in previous years, the EAS will provide a number of grants for mainly young colleagues to travel to Armenia and to attend the JENAM. The grant program of the EAS has been very successful over the past years; several ten thousands of Euro have been spent on such grants. It is one of the prime goals to continue this grant program in the future at an increased level.

Another prime task will be to prepare a document on employment opportunities in Europe. Talks on this subject have been given at the European afternoon during the IAU General Assembly in Prague and as we learned there, not only the recruitment procedures vary strongly from country to country but also research fellowships and faculty positions are organized in many different ways. For instance, in France positions are distributed in a mainly centralized way while in Germany the position are given out by individual institutions. Such a document on employment opportunities will be of big help for all colleagues looking for a position in Europe.

The last decade has been characterized by the emergence of many European networks, the ERA-Nets funded by the European Commission. These are networks operating on different levels: OPTICON, RadioNet, and ILIAS, are run at the level of 'working astronomers', ASTRONET is run by national funding agencies, ESFRI by government policy makers, the European Research Council is an independent Council of distinguished scientists which decides on financing major future research infrastructure, etc. And there are more, like for instance the European Science Foundation, which published together with EAS in 2004 the 'European Survey of National Priorities in Astronomy'. Of course, a European wide organization like the EAS would be a natural partner for many of these European networks. Besides the collaboration with the ESF, the EAS has so far an observer status at OPTICON. Clearly, one of the major goals of EAS Council has to be to increase the visibility of the EAS among European policy makers and to play a major role in the shaping of European astronomy.

I hope I have given you some outlook on the priorities for the next couple of years. Of course, any suggestion for other topics we should address are more than welcome. I look forward to four years of exciting and productive collaboration with my Council members, the office in Geneva, our Affiliated Societies and our EAS members which will, hopefully, move European astronomy another big step forward.

Joachim Krautter
President of EAS

NEWS

JENAM 2007

JENAM-2007 (the Joint European and National Astronomy Meeting) will take place in Yerevan (Armenia) in 20-25 August 2007, and will be the 15th Annual Meeting of the European Astronomical Society (EAS) and the 6th Annual Meeting of the Armenian Astronomical Society (ArAS). This JENAM is entitled "Our non-stable Universe" and its dedicated web site is at:
http://www.aras.am/JENAM-2007/index.htm

JENAM-2007 will consist of 6 Plenary sessions (invited reviews on hot topics of modern astrophysics, 8 EAS Symposia, and 7 Special Sessions (SPS). The EAS symposia will last 2-3 days each, 4 symposia in parallel. The SPS will last 2 days each, 3 or 4 SPS in parallel. Poster sessions will be organized as well for each of the symposia and SPS.

During the JENAM, the EAS General Assembly and EAS Council meetings will take place, as well as a Job Market for young scientists, exhibitions, a number of social events, etc.

Beside the joint excursions on Wednesday, August 22 and Saturday, August 25, additional tours will be organized for accompanying persons and those scientists not attending sessions on the given days.

The opening and closing sessions, EAS symposia and special sessions will be organized in the conference halls and auditoria of the Yerevan State University (YSU). Exhibitions and poster sessions will be organized at the entrance halls. The participants will stay at the Yerevan central hotels, and buses will take them every day to the University and back. A detailed information on travel to Armenia and visas, Yerevan hotels, and local conditions will be available soon.

The proceedings of the JENAM-2007 will be published in the EAS proceedings series in 2008.

ORGANIZERS

European Astronomical Society (EAS)
Armenian Astronomical Society (ArAS)
Yerevan State University (YSU)
Byurakan Astrophysical Observatory (BAO)

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EAS SYMPOSIA

EAS S1: Extrasolar Planets
EAS S2: Searching for Proto-Planets around Young Stars
EAS S3: Violent Phenomena in Young Stars
EAS S4: High-Energy Astrophysics
EAS S5: Activity in Galaxies
EAS S6: Dynamics of Galaxies and Galactic Nuclei
EAS S7: Observational Cosmology
EAS S8: Science with Virtual Observatories

JENAM-2007 SPECIAL SESSIONS (SPS)

SPS1: Stellar Structure and Evolution
SPS2: New Developments in Asteroseismology
SPS3: Gravitational Wave Astrophysics
SPS4: Astronomy from the Antarctic plateau
SPS5: Astronomy Education in Europe
SPS6: Archaeoastronomy
SPS7: Numerical Astrophysics

Note: some of the SPS may be cancelled if there is not enough interest from the pre-registered participants.

REGISTRATION FEES

EAS members	200 Euros
Other participants	240 Euros
Accompanying persons	120 Euros

EAS AND ARAS TRAVEL GRANTS

A limited number of EAS and ArAS travel grants will be available mainly reserved for young participants and scientists from countries with limited resources. An application form will be available after the period of the pre-registration (December 31, 2006). Those who are going to apply for a grant are encouraged to pre-register as soon as possible.

PRE-REGISTRATION

The deadline for the pre-registration is December 31, 2006. The online pre-registration form can be found at http://www.aras.am/JENAM-2007/pre-registration.htm

If you have problems with web access or with online registration, please send the completed form as an e-mail attachment to aregmick@apaven.am.

DEADLINES

Oct 1, 2006	Deadline for proposals for EAS symposia and Special Sessions (SPS)
Oct 15, 2006	First Announcement with Pre-registration form
Dec 31, 2006	Deadline for Pre-registration
Jan 15, 2007	Second Announcement with a call for Registration
May 1, 2007	Deadline for Submission of Abstracts and Travel Grant Applications
Jun 1, 2007	Applicants to be informed on outcome of Travel Grant Applications and Confirmation of Acceptance of Abstracts

Jun 15, 2007	Deadline for Registration and Hotel Reservation
Jun 30, 2007	Final Submission of Abstracts of accepte papers for the Abstracts book
Jul 15, 2007	Final Announcement with the detailed Program
Aug 20-25, 2007	JENAM-2007 in Yerevan
Oct 31, 2007	Deadline for submission of papers for publication in the Proceedings

CONTACTS

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For an inquiry and discussion of the details of the EAS symposia and JENAM special sessions, please contact the corresponding SOC Chairs and the Conveners. More contact details will be available in future announcements.

ASTRONET: Strategic Planning for European Astronomy

In the last Newsletter, past EAS President Harvey Butcher briefly mentioned the new European planning initiative ASTRONET. Here we give a more thorough account of ASTRONET's background, aims, and plans (see news and more detail at
http://www.astronet-eu.org).

ASTRONET is led by a group of major European research agencies, including ESO and ESA, and is funded for four years by the EC under the ERA-NET scheme. Its vision is to consolidate and reinforce the position of Europe as a front-line player in astronomy well into the 21st century. To this end, ASTRONET aims to establish a comprehensive, long-term planning process for all of European astronomy – at all wavelengths, from the ground and from space, and for all of Europe.

In the process, ASTRONET will address both long-term scientific goals, infrastructure needs, and programme and resource management issues that impede effective pan-European cooperation. The `Decadal Surveys' in the USA are an inspiration, but ASTRONET has even broader goals, which will be pursued in separate steps:

The Science Vision

As its first and most visible effort, ASTRONET will develop a Science Vision to identify key research priorities for European astronomy over the next 15-25 years, making maximum use of existing national and regional plans to maintain consistency. This effort is led by a Working Group, assisted by expert panels addressing the following four broad, overarching questions that span the whole range from cosmology and fundamental physics to the Solar system and our own place in the Universe:

A: Do we understand the extremes of the Universe?
B: How do galaxies form and evolve?
C: How do stars and planets form?
D: How do we fit in?

The working group and panel members (see the ASTRONET web site) have been selected purely for their scientific eminence, not as representatives of any particular discipline or project, so as to give a balanced view of the future scientific challenges. A draft of the report will be published in November 2006, and comments from the community are invited via the web and directly at a large Symposium in January 2007. The final version of the report will then be prepared and published.

The Infrastructure Roadmap

Taking over from the Science Vision in spring 2007, an Infrastructure Roadmap will be developed to give provide an overview of the tools needed to reach the goals of the Science Vision. It will discuss not only the next generation of observational facilities (large optical and radio telescopes, space observatories and planetary missions, etc.), but the whole "food chain" from technology development, including computing facilities, networks, and virtual observatories, to theory, modelling, and human resources. A recommended implementation plan will be developed at a later stage.

Close coordination will be maintained with the existing EU-funded, discipline oriented initiatives (e.g., OPTICON, RadioNet, ILIAS and ASPERA, ELT and SKA Design Studies, etc.), but ASTRONET considers a much longer time span than the 6th and 7th Framework Programmes (2004-15). The European Strategy Forum for Research Infrastructures (ESFRI), the European Science Foundation, and the European Research Council will be contacted as appropriate. A similarly open procedure as adopted for the Science Vision will be followed in the preparation of the final report on the Infrastructure Roadmap.

Resource and Programme Management

At present, no reliable and consistent statistics exist on the overall human and financial resources deployed in European astronomy. Questions on, e.g., the staffing and funding for cosmology or astrobiology in Europe cannot be readily answered. Similarly, such national strategic plans for astronomy as may exist at all are different in scope, form, and schedule, as are the national systems for inviting, evaluating, and funding research proposals in astronomy. A better foundation for rational long-term planning at the European level is needed.

In parallel with the above community-oriented initiatives, ASTRONET is therefore conducting a survey of the organisation, funding, and national and regional strategic plans for astronomy in Europe. On this basis, ASTRONET will develop proposals for better-coordinated and more effective programme and resource management procedures in European astronomy. A pilot call for a jointly funded research project will be issued at the end.

The Role of ASTRONET in Planning for European Astronomy

But what will ASTRONET do that is not already being done? After all, both ESA and ESO have already developed long-term plans for their future investments; ESFRI is collecting plans for large European infrastructures for all European science; and the OECD Global Science Forum does the same on the global scene. How many planning exercises does European astronomy need?

The key point to remember here is that the known EC budget can fund only a tiny fraction of the new research infrastructures that Europe wants. The lion's share must come from the national funding agencies – including the budgets of ESO and ESA, etc., whose plans cover their own fields but not, e.g., radio astronomy or astroparticles, not to mention the coordination of national resources and funding procedures.

The agencies know that, in the end, they are asked to pay for essentially all of the wish-list of European astronomy, so they want to see how all the astronomy-related projects fit together. And the remit of ESFRI is limited to the largest infrastructures, but does not include recommending priorities, schedules, modes of cooperation, or coherence across a wide discipline such as all of astronomy.

On this background, ASTRONET should be understood as an opportunity offered by the agencies to European astronomy to prove that we can define our own priorities and present a coherent long-term plan that will convince them that their money will be well spent by us. Which forum they may choose for making their decisions (the ESO Council mentioned by Harvey Butcher or one of several alternatives) will be decided by them. But if we succeed, a few more of our ambitious hopes may be eventually realised. If we fail, we will all be worse off.

As the first-ever European planning initiative of such a wide scope, ASTRONET should be seen as a pilot project. The task will certainly not be finished three years from now, but lessons will have been learned on how to address the multitude of complex issues involved. The more feedback we get from the community, the better will we be able to design the long-term process that will eventually replace ASTRONET.

Involving All of Europe

Engaging all intellectual resources in Europe is crucial for the success of these initiatives which, we hope, will help to shape a strong and competitive future for all of European astronomy. ASTRONET is therefore actively contacting astronomical communities and research and funding agencies in all EU Member and Associated States to enlist their participation in making these visions a reality. Their input is needed, both in developing the Science Vision and Infrastructure Roadmap now, and in designing more effective means for pan-European scientific cooperation for the future. Only then will ASTRONET truly succeed.

What Role for the EAS?

Because ASTRONET needs to reach both as many funding agencies and as many astronomical communities in Europe as possible in a short time, ASTRONET has already set up its own network of contacts in all the EU Member and Associated States. Could there also be a constructive role for the EAS, with benefits for both sides, given that its membership is limited and does not include the funding institutions?

We see two immediate options: First, the EAS is in direct contact with the affiliated national astronomical societies. The EAS could not only help to make them aware of ASTRONET's aims and activities, but also encourage them to organise national discussions of the way their communities want European astronomy develop in the future, and the measures they find suitable in pursuit of those goals.

Second, the EAS includes not only the present EU and the formally associated countries in its membership, but also the European communities outside this geographical boundary. To be sure, political barriers currently prevent their full participation in formal cooperation initiatives such as ASTRONET, but this is surely an untenable situation in the longer term, and the EAS could help to dismantle these last vestiges of the Iron Curtain. We hope that the EAS Council will consider these options and perhaps propose additional activities of mutual benefit.

Europe and the World

Finally, there is an even wider perspective to the ASTRONET initiative: Astronomy's greatest ambitions for the future will no doubt only be achieved through truly global planning and cooperation. For Europe to play an effective role in shaping the global astronomy projects of tomorrow, as befits its scientific, technical, and financial potential, the European astronomers and research institutions must sort out their own plans and priorities first. Only then can we aspire to playing more than second or third fiddle in the future.

Johannes Andersen, Chair, ASTRONET Board
Anne-Marie Lagrange, ASTRONET Coordinator

News From OPTICON

OPTICON's planning for the upcoming FP7 opportunity is beginning to increase steadily. The ideas presented at our June planning meeting in Edinburgh have been reviewed and steps are being taken to produce a coherent and affordable programme ahead for the FP7 call. In the case of integrating activites like OPTICON and Radionet this call is expected in about a years time. Meanwhile our FP6 activities continue to run smoothly.

OPTICON was represented at the IAU General Assembly in Prague by Suzanne Howard, Anselmo Sosa and John Davies who staffed a small booth in the exhibition hall and distributed many copies of the OPTICON ELT science case, handouts and other literature. A presentation at the EAS session was also given.

Network N2, a number of activites based around the telescopes in the Canary Islands, continues to make good progress. Work on site testing at both islands is progressing, the Joint Information System for Solar Physics is up and running. A DVD illustrating the astronomical facilites on the islands has been prepared and will be released soon.

The NUVA ultra-violet astronomy network held a joint discussion at the Prague IAU and the planned 2007 conference has now been announced. You can find the details of this meeting at
http://www.mat.ucm.es/~aig/investigacion/index.html

The Key Technologies Network has had several meetings, including one in La Palma to investigate the usefulness of developing the 4.2 metre William Herschel Telescope as a testbed for adaptive optics.

The Interferometry Working group has published its Technology Roadmap for Future Interferometric Facilities (eds J.Surdej, D. Caro and A. Detal) with the co-operation of Liege University, Institute of Astrophysics and Geophysics. This publication is based on the workshop held at the 2005 JENAM meeting.

The ELT working group continues to work hard in collaboration with ESO and details of the joint ESO-OPTICON meeting "Towards the European ELT" can be found at http://www.elt2006.org. As hoped the ESFRI European Infrastructure roadmap includes an ELT as a project suitable for the EU to support. You can read the ESO press release at http://www.eso.org/outreach/press-rel/pr-2006/pr-40-06.html or download the whole ESFRI Roadmap document (much of which concerns non-astronomy projects) from http://cordis.europa.eu/esfri/.

The OPTICON telescope access programme, which offers travel grants to astronomers who win time on a suite of European operated solar and night time telescopes continues to be very popular, with an oversubscription of eligible proposals by a factor of two. The telescope directors have resolved to continue the programme at its present level until the end of FP6, meaning that four application cycles still remain for new users to take advantage of the programme. We particularly encourage applications from astronomers in countries with no large infrastructures of their own. Note that the Liverpool robotic telescope is now eligible for the programme and welcomes non UK/Spanish users to apply. See http://www.otri.iac.es/opticon/ for rules and application procedures for the whole network. In a related area, work is underway to develop a common proposal submission tool which may eventually be adopted for a number of European telescopes.

All Six Joint Research Activities, in such things as AO, detectors, interferometry, smart focal planes and VPH gratings continue to make good progress, details can be found in the papers presented to the recent Board meeting and which can be accessed via the 'meetings' section of the Opticon web page.

As always more information can be obtained from www.astro-opticon.org or by contacting the project scientist, John Davies (jkd@roe.ac.uk) or the chairman Gerry Gilmore (gil@ast.cam.ac.uk)

John Davies,
OPTICON Project Scientist,
UKATC, Royal Observatory, Edinburgh

IAU Task Force PDPP: New Issue of Newsletter SCAN-IT

The IAU Task Force for the Preservation and Digitization of Photographic Plates (PDPP) has recently issued a new version of its Newsletter, SCAN-IT. The document can be accessed as zipped PDF or PS at
http://www.lizardhollow.net/

This issue carries updates on plate digitizing and archiving activities completed or underway, and discussions on the merits of different types of scanning equipment, both custom-built and commercial.

Your interest and your support are invaluable to the groups who are currently attempting to bring this heritage of unrepeatable data back the modern world for general use.

We are also building a list of references to research based on archival data, and will be glad to receive any input.

Elizabeth Griffin
(Elizabeth.Griffin@nrc.gc.ca)
Chair, PDPP

Membership discount for personal subscription to The Astronomy and Astrophysics Review

Springer is happy to offer members of the EAS a discount on the combined personal subscription to the print and online editions of The Astronomy and Astrophysics Review. For a description of the journal, price information and online subscription please go to
http://springer.com/journal/00159.

Dr. Ramon Khanna
Editor Physics & Astronomy,
Springer, Heidelberg, Germany

Conference on: _Future Professional Communication in Astronomy

A conference on the future of professional communication in Astronomy and its impact on evaluation will take place in Brussels on 10-13 June 2007. The conference will draw from the changes in online publishing in astronomy over the past 15 years, to address issues such as: the future of electronic publishing, new publishing models, the role of learned societies, as well as bibliometric and other evaluation criteria.

For more information visit:
http://vizier.u-strasbg.fr/~heck/epub2007.htm

SPACE SOLAR FACILITIES

ULYSSES - EXPLORING THE 3-D HELIOSPHERE

Introduction

Ulysses is an exploratory mission being carried out jointly by ESA and NASA. Its primary objective is to characterise the uncharted high-latitude regions of the heliosphere within 5 AU of the sun, under a wide range of solar activity conditions. The spacecraft was launched by the Space Shuttle on 6 October 1990, using a powerful upper-stage to inject it into a direct Earth/Jupiter transfer orbit. A gravity-assist manoeuvre at Jupiter in February 1992 placed Ulysses in its final sun-centred out-of-ecliptic orbit, which has a perihelion distance of 1.3 AU, an aphelion of 5.4 AU, and an 80º inclination with respect to the solar equator. The orbital period is 6.2 years.

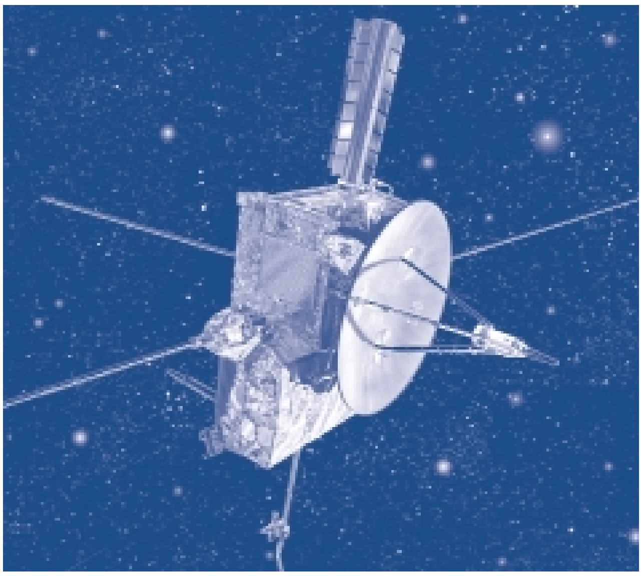


Figure 1. The Ulysses spacecraft (artist impression). D. Hardy.

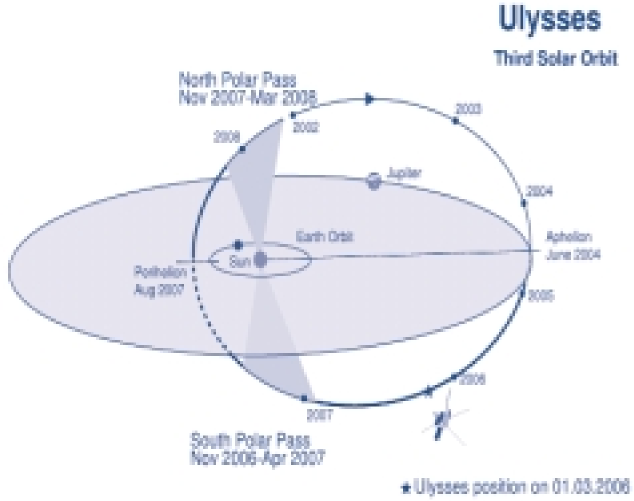


Figure 2. The Ulysses trajectory viewed from 15º above the ecliptic plane.

The European contribution to the Ulysses programme consists of the provision and operation of the spacecraft and about half of the experiments. NASA provided the launch aboard the space shuttle Discovery (together with the upper-stage motor) and the spacecraft power generator, and is responsible for the remaining experiments. NASA also supports the mission using its Deep Space Network (DSN).

The broad range of phenomena that are being studied by Ulysses includes the solar wind, the heliospheric magnetic field, solar radio bursts and plasma waves, solar and interplanetary energetic particles, galactic cosmic rays, interstellar neutral gas, cosmic dust, and gamma-ray bursts. Nine sets of instruments provided by international teams make up the scientific payload. These include magnetometers, solar wind electron and ion instruments, energetic charged particle and cosmic ray detectors, a radio and plasma wave experiment, a cosmic dust instrument, an interstellar neutral gas instrument and a gamma-ray burst detector.

Scientific Highlights

While the main focus of the mission is clearly the heliosphere and its variations in time and space, the investigations carried out by Ulysses cover a wider range of scientific interest. The unique perspective offered by Ulysses' orbit and the comprehensive set of science instruments carried on board the spacecraft, have enabled scientists to make many groundbreaking discoveries, some in areas that were not even imagined when the mission was first planned. Ulysses "firsts" include:

First observations of particles from solar storms over the solar poles

A fundamental Ulysses discovery is that energetic charged particles are able to move much more easily in latitude than was imagined prior to launch. Electromagnetic forces tie charged particles to the magnetic field lines in space, and large excursions in the direction of the field were not anticipated. If the Sun did not rotate, the solar wind would drag open magnetic field from the Sun's surface radially outward in all directions. Because of the rotation, however, the field is wound into an Archimedes spiral pattern in which the field lines lie on cones of latitude. Under these conditions, charged particles would not be able to move easily in latitude. The ideal situation described above apparently does not apply in reality. Ulysses observed large numbers of energetic particles over the solar poles, far away from the location of the solar storms that created them. Either the particles were able to jump across the magnetic field, or the field lines themselves undergo large excursions, enabling low-latitude sources to be connected to high latitudes. Scientists are still debating which answer is the correct one. In any case, Ulysses has revealed that previous ideas as to how particles are transported in the heliosphere need a thorough revision. This is not only of academic interest. Astronauts in deep space could be exposed to radiation from sources that were previously considered to be at a safe location.

<u>First direct measurements of interstellar dust and neutral helium gas</u>
Astronomical observations suggest that the Sun is presently moving through a warm, tenuous interstellar cloud made of dust and gas, one of several that make up our local galactic neighbourhood. Scientists are eager to learn as much as possible about this local interstellar environment and its interaction with the heliosphere. Using instruments on board Ulysses, we are able, for the first time, to make direct measurements of dust grains and neutral helium atoms from the local cloud that penetrate deep into the heliosphere. These measurements have allowed scientists to determine the flow direction of the dust and gas, as well as the density and temperature of the neutral helium and the mass distribution of the dust particles. This in turn is helping us to understand the properties of the local cloud as a whole.

<u>First measurements of rare cosmic-ray isotopes</u>
Together with the interstellar neutral gas and dust, cosmic-ray particles are the only sample of material from outside the heliosphere that is available for direct in-situ study. By measuring the composition of cosmic-ray nuclei, scientists are able to distinguish between different theories of their origin. This is particularly true of the so-called isotopic composition (isotopes are nuclei having the same atomic number, or charge, but different atomic weights, e.g. 20Ne and 22Ne). Ulysses carries an instrument that is able, for the first time, to make the precise measurements of rare cosmic-ray isotopes needed to test current theories of cosmic ray origin.

<u>First measurements of so-called "pickup" ions of both interstellar and near-Sun origin</u>
Pickup ions are created in the heliosphere when neutral atoms become ionized by charge-exchange with solar wind ions or by photo-ionization. Thanks to Ulysses, an entire branch of science has been built around pickup ions. New sources have been discovered. Solar wind particles appear to become embedded in dust grains near the Sun, and are subsequently released to form a pick-up ion population known as the "inner source". Comets emit neutrals that form pickup ions, and have an extended tail that can be observed, from which the composition of the comet can be determined. Interstellar neutral gas is a sample of the interstellar medium and thus the composition of the Galaxy in the present epoch, as opposed to when the solar system was formed 4.5 billion years ago. The isotope 3He was measured in the interstellar pickup ions by Ulysses, and provides an important constraint on the evolution of matter in the universe. Using pickup ion measurements from Ulysses, comet tails have been detected as far away as 3.5 AU (more than 500 million km) from the nucleus.

Other areas where Ulysses data are providing new and exciting insights range from the origin of the solar wind itself, and the way the Sun's magnetic field reverses polarity, to the nature of the boundary of the heliosphere and the interstellar medium. Ulysses data have even provided important constraints on fundamental cosmological concepts like the evolution of matter in the Universe.

The Future
With all these successes already under its belt, what lies ahead for Ulysses? ESA and NASA have approved funding to continue spacecraft operations until the end of March 2008. This will enable scientists to study the 3-D heliosphere over a large fraction of the Sun's 22-year magnetic cycle. In February 2007 Ulysses will visit the Sun's south pole for the third time. Conditions are expected to be similar to those encountered in 1994, with one major difference: even though the Sun will once again be close to its activity minimum, its magnetic field polarity will be opposite to that during the first polar pass. This will provide a unique opportunity to obtain closure on questions concerning the movement of cosmic rays and interstellar dust particles in the heliosphere, as well as a puzzling asymmetry in the Sun's magnetism that was discovered during the first polar passes.

Ulysses Data Archive
Data from the Ulysses investigations and flight project are being archived and made accessible to the public through two channels: the ESA Ulysses Data Archive at ESTEC, and NASA's National Space Science Data Center (NSSDC). The ESA archive and other information on the mission is accessible via the Ulysses homepage:

<u>http://helio.esa.int/ulysses.</u>

Richard G. Marsden, ESA
Ulysses Mission Manager

CORONAS-F MISSION: OBSERVATIONS OF THE SUN AND MANIFESTATIONS OF SOLAR ACTIVITY

The Russian-Ukrainian satellite CORONAS-F was launched to the orbit round the Earth (initial height of about 500 km, inclination of 83 deg.) on July 31, 2001 by the Cyclon missile from the Plesetsk launching ground. It was the second satellite of the Russian CORONAS Program and followed CORONAS-I, which had been orbiting the Earth from 1994 to 2001. Among other objectives, the mission was aimed at the study of the Sun and the effect of solar activity on the Earth's environment in different phases of the cycle. The mission completed its task on December 6, 2005 after 4 years and 4 months of operation as a result of natural evolution of the orbit.

CORONAS is the English transliteration of the Russian acronym produced from the full name of the mission "Complex Orbital Near-Earth Observations of Solar Activity".

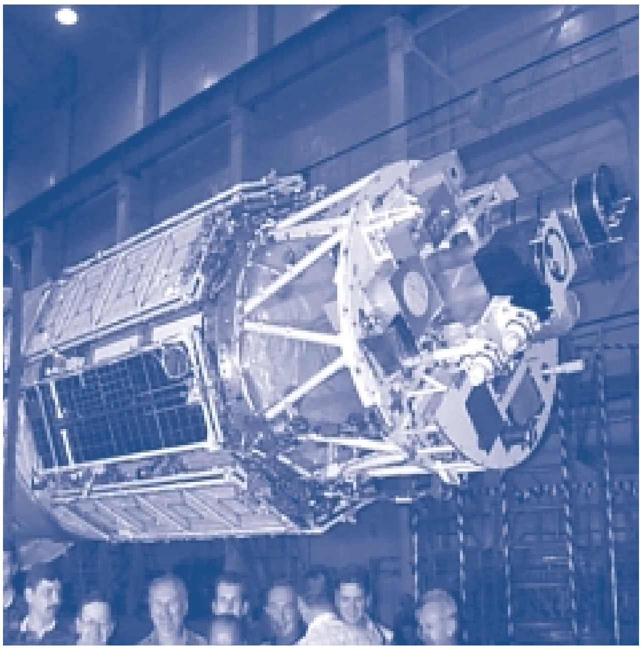


Figure 1. Satellite CORONAS-F docked to the Cyclon missile.

The scientific payload of the mission comprised 15 instruments listed in the Table below together with their measuring bands. The measuring range of the scientific complex covered a broad spectrum of wavelengths from optical to gamma radiation. The control of the onboard scientific devices was exerted from IZMIRAN. The telemetry was received at Neustrelitz (Germany).

List and Measuring channels of the CORONAS-F instruments

Helioseismology	Measuring ranges
Spectrophotometer DIFOS	3500-15000 Å
Solar Flares and Imaging of the Sun	
Gamma Spectrometer HELIKON	10 keV - 10 MeV
Flare Spectrometer IRIS	2 - 200 keV
X-ray Spectrometer RPS-1	2 - 20 keV
Spectrophotometer DIAGENESS	3 - 7 Å
X-Ray Spectrometer RESIK	1 - 6 Å
Amplitude-Time Spectrometer AVS	3 - 30 keV; 0,1 - 0,8 MeV; 2 - 80 MeV
Solar Spectropolarimeter SPR-N	20 - 100 keV
SPIRIT Experiment(Solar X-Ray Telescope SRT-K, X-Ray Spectroheliograph RES-K)	1,85 - 335 Å
Ultra Violet Emission of the Sun	
Solar UV Radiometer SUFR-Sp-K	10 - 1300 Å
Solar UV Spectrophotometer VUSS-L	1216 Å +/- 50 Å
Solar Cosmic Rays	
Gamma Emission Spectrometer SONG	0,03 - 100 MeV; 0,3 - 20 MeV; n > 20 MeV; e > 50 MeV; p > 70 MeV
Cosmic Rays Monitor MKL	1 - 200 MeV; e 0,5 - 12 MeV
Cosmic Emission Spectrometer SKI-3	1,5 - 20; 4 - 40 MeV/n

The most important facility was the X-ray complex developed and manufactured at the P.N.Lebedev Physical Institute of the Russian Academy of Sciences in cooperation with some other scientific institutions and universities. It was used in a vast program on localizing many active events in the Sun and studying their morphology. A few most outstanding solar flares were recorded (Fig.2). Repeated mass ejections were observed to occur in the same magnetic configurations. Observations in the resonance line MgXII (8.42A) made it possible to reveal and investigate a new class of the phenomena in the solar corona — fast dynamic plasma features with the temperatures up to 20 million degrees (see Fig. 3).

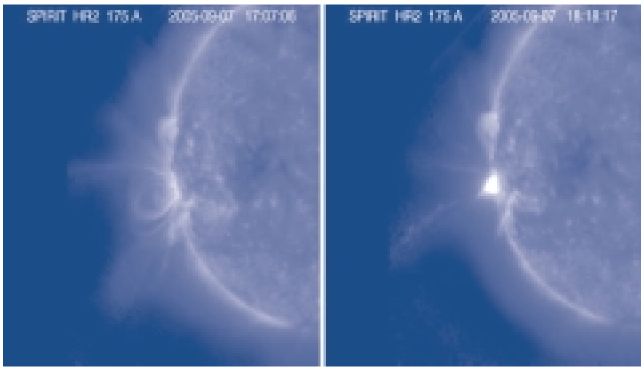


Figure 2. Limb structure of the solar corona under pre-flare conditions (left) and in the maximum phase (right) of the importance X17 flare of September 7, 2005.

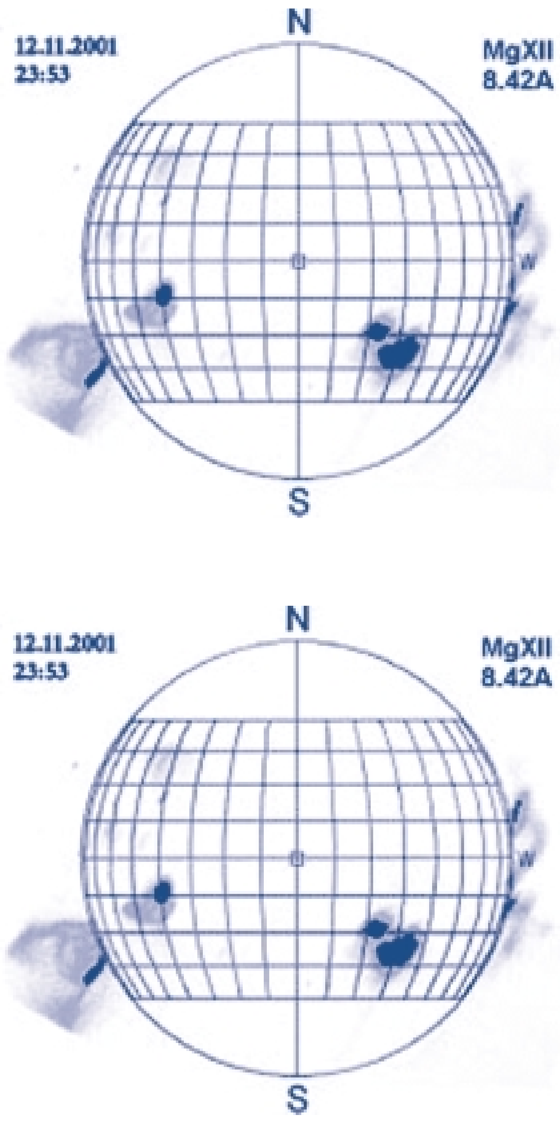


Fig.3. Hot (up to 20 million deg.) plasma features in the solar corona as observed in the MgXII (8.42A) spectral line by solar X-ray telescope.

Observations with a high temporal and spectral resolution provided a wealth of new data on various physical processes in solar flares. A high linear polarization of hard X-rays suggesting the presence of accelerated electron beams was measured in the impulsive phase of a major flare. The typical oscillation periods of X-ray emission reflecting the variation of physical conditions in active regions were determined at different stages of a flare. The gamma-lines of nuclear reactions in flares were recorded, as well as the capture line of the flare-generated neutrons and annihilation line of electrons and positrons. The data obtained allowed us to study atomic processes in solar flares and to perform a comprehensive spectroscopic diagnostics of the flare-generated plasma. For the first time, we could measure and analyze the full profile of the spectral lines from the most outstanding flares. The absolute shifts of X-ray spectral lines and the radial velocities of the emitting plasma were measured all over the flare growth phase. New spectral lines were revealed in the emission spectrum of the solar plasma, including the ion lines for high values of the quantum number n. Hundreds of spectra of the helium-type ions were measured, and the temperature dependence of the ion spectra was studied at different levels of solar activity. The absolute content of some chemical elements in the solar corona was estimated.

A continuous series of data on solar energetic particle fluxes was obtained along the CORONAS-F orbit with the instruments of the Solar Cosmic Ray complex. These data were used to study the dynamics of the Earth's radiation belts and penetration of energetic particles into the magnetosphere during strong geomagnetic disturbances. High-energy gamma rays and neutron fluxes generated in the major flares of October-November 2003 were recorded at the Earth's orbit.

The solar UV fluxes were measured, and the contribution of the major flares to the total UV flux was established not to exceed usually a few percent in the observed band (about 1200 Å). The generation time sequences of the flare radiation in different spectral bands were studied, which illustrate different heights of the flare energy release region.

The multi-channel spectrophotometer DIFOS recorded the eigenmodes (p-modes) of global oscillations of the Sun in a broad wavelength range. The oscillation amplitudes were found to increase significantly in the UV part of the spectrum, and a region of noticeable dissipation of oscillations was revealed at middle depths in the photosphere.

A successful operation of the CORONAS-F solar observatory was the result of joint effort of a large team of scientists, engineers, and experts from Russian, Ukrainian, and foreign organizations under the leadership of the N.V.Pushkov Institute of Terreatrial Magnetism, Ionosphere, and Radio Wave propagation of the Russian Academy of Sciences (IZMIRAN). The CORONAS space mission comprises a series of three satellites: CORONAS-I (1994-2001), CORONAS-F (2001-2005), and CORONAS-PHOTON yet planned to be launched. It forms part of the long-term research program on solar-terrestrial physics developed and implemented by the Russian Academy of Sciences within the frames of the Russian Federal Space Program under the auspices of the Federal Space Agency.

V.D.Kuznetsov
CORONAS-F Project Scientist,
Director of IZMIRAN

SOHO: The Solar Heliospheric Observatory

Introduction

The Solar and Heliospheric Observatory (SOHO) is a project of international cooperation between ESA and NASA to study the Sun, from its deep core, through the outer corona, the solar wind, and the interaction with the interstellar medium. Since its launch on 2 December 1995, SOHO has revolutionized our understanding of the Sun. It has provided the first images of structures and flows below the Sun's surface and of activity on the far side of the Sun. It has revealed the Sun's extremely dynamic atmosphere, provided evidence for upward transfer of magnetic energy from the surface to the corona and identified the source regions of the fast solar wind. Furthermore, it has revolutionized our understanding of solar-terrestrial relations and dramatically improved our space weather forecasting capabilities. The findings have been documented in an impressive and continuously growing number of scientific publications: over 2,500 papers in refereed journals since launch, representing the work of over 2,300 individual scientists. At the same time, SOHO's easily accessible, spectacular data and fundamental scientific results have captured the imagination of the space science community and the general public alike. As a byproduct of the efforts to provide real-time data to the public, amateurs have come to dominate SOHO's discovery of over 1,200 Sun-grazing comets.

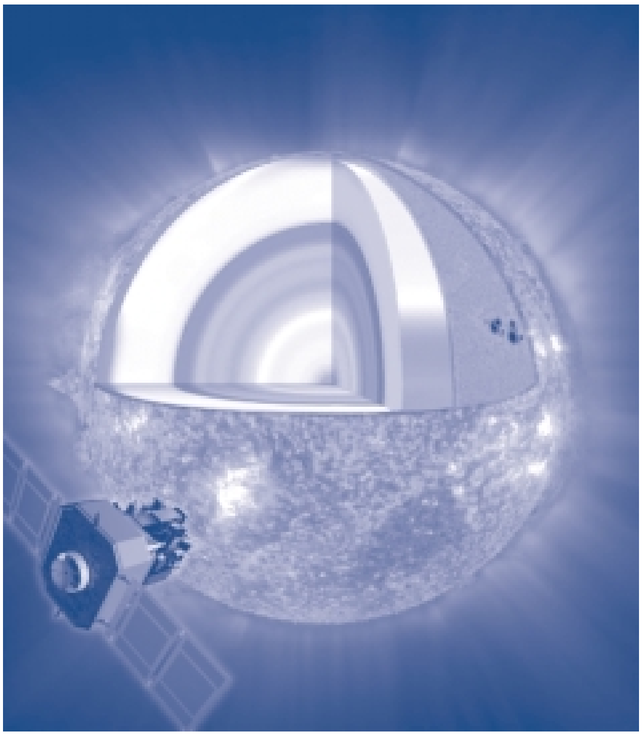


Figure 1. SOHO – an ESA/NASA mission to study the Sun from its core to the corona and the solar wind.

Mission overview

A consortium of European space companies led by prime contractor Matra Marconi Space (now EADS Astrium) built SOHO under overall management by ESA, and twelve international consortia developed its suite of twelve instruments. NASA launched SOHO on 2 December 1995, and it was inserted into a halo orbit around the Lagrangian point L1 in February 1996.

The SOHO Experiment Operations Facility (EOF), located at NASA's Goddard Space Flight Center, serves as the focal point for mission science planning and instrument operations. Six of the twelve SOHO Principal Investigator Teams are represented by teams resident at the EOF, where they receive telemetry, process these data to determine instrument commands, and send commands directly from their workstations through the ground system to their instruments.

Making the Sun transparent

Just as seismology reveals the Earth's interior by studying earthquake waves, solar physicists probe the interior of the Sun using a technique called helioseismology. The oscillations detectable at the visible surface are due to sound waves reverberating through the Sun's inner layers. These oscillations are usually described in terms of normal modes. By precisely measuring the mode frequencies, one can infer the Sun's temperature, density, atomic abundances, interior structure, and the age of the solar system, and even pursue such esoteric matters as testing the constancy of the gravitational constant.

The Michelson Doppler Imager (MDI), one of three helioseismology instruments on SOHO, delivers high-quality data from oscillations of the whole Sun. These observations have revealed strong variations in the velocity of the plasma in the solar interior, and the presence of a shear layer at the base of the convection zone. This layer is of particular interest, since this is where the solar dynamo that creates the Sun's magnetic field is believed to operate. In this region, the rotation profile changes abruptly. Near the equator the outer layers rotate faster than the inner layers. At mid-latitudes and near the poles, the situation is reversed.

Since MDI started to deliver helioseismic information at finer spatial scales than previously available, the new field of "local area helioseismology" has developed rapidly. New methods allowed the construction of the first true 3-D images and flow maps of the interior of a star, and even first images of the far side of our Sun. Applying the novel acoustic tomography method to MDI data, scientists could for the first time study the structure of sunspots below the Sun's surface.

SOHO, the space weather watchdog

Besides emitting a continuous stream of plasma in the solar wind, the Sun periodically releases huge amounts of matter in what are called coronal mass ejections (CMEs). CMEs are the most powerful eruptions in the solar system, with billions of tons of plasma being propelled from the Sun's atmosphere into space at speeds of up to 2000 km/s. When directed towards Earth, they can cause severe geomagnetic disturbances.

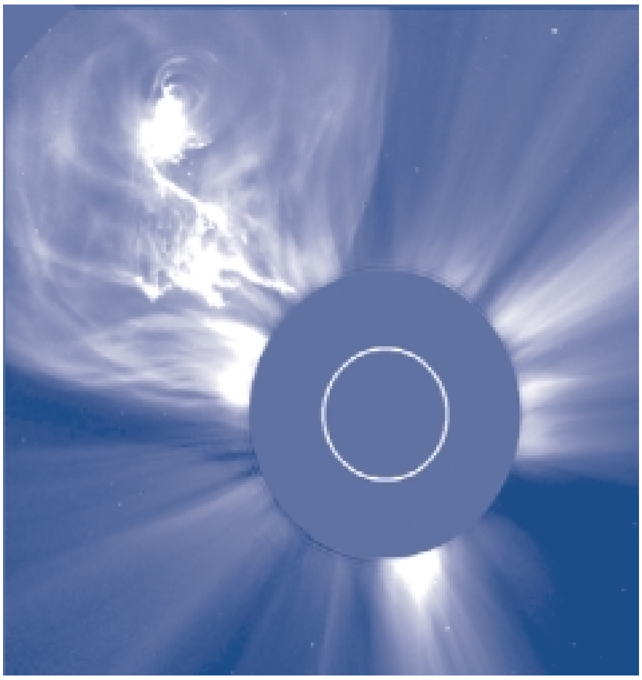


Figure 2. SOHO/LASCO image of a coronal mass ejection showing stunning details in the ejected material. The direct sunlight is blocked by an occulter (red disk), revealing the surrounding faint corona. The white circle represents the approximate size of the Sun.

Apart from causing beautiful aurorae borealis, the disturbances associated with CMEs can damage satellites, disturb telecommunication devices, pose a radiation hazard to orbiting astronauts, lead to corrosion in oil pipe lines and cause current surges in power lines. As our society becomes increasingly dependent on space-based technologies, our vulnerability to “space weather” becomes more obvious, and the need to understand it and mitigate its effects becomes more urgent. In recent years, forecasting the conditions in the near-earth environment and the “geo-effectiveness” of CMEs and solar flares has become one of the key research areas in solar and solar-terrestrial physics, and SOHO is playing a pioneering and leading role in this new discipline. While satellites that perform in-situ measurements in near-earth orbits can only give a roughly two hour alert for solar storms, SOHO’s coronagraphs and EUV imager observe the source of CMEs and flares and are thus able to give up to three days warning, sufficient time to make provisions to save costly equipment. SOHO LASCO and EIT have become the primary source of operational information on the location, speed, and orientation of CMEs from the earth-facing hemisphere of the Sun. Three particle instruments on SOHO complement these remote sensing observations by in situ measurements of the arrival of the CME and energetic particles at the Lagrangian point L1.

Measuring the Total Solar Irradiance

SOHO’s VIRGO instrument is monitoring the total solar irradiance (TSI), also known as the ‘solar constant’. Indications of long-term changes of the Sun’s total irradiance would have a broad social and political impact as governments have to devise strategies in response to global warming. Using sophisticated calibration models, the VIRGO team has constructed composites of TSI measurements from SOHO and other spacecraft over the last 26 years. From this composite record, it appears that there is no evidence for a significant long-term trend in the TSI, i.e. the total radiation from the Sun does not show any systematic brightness increase or decrease on observed time scales. However, while the total solar irradiance varies by less than 0.1% over the 11-year solar cycle, the irradiance in the extreme ultraviolet (EUV) part of the spectrum changes by as much as 30% on the time scale of weeks and by a factor of 2 to 100 (wavelength dependent) over the solar cycle. Detailed knowledge of the solar spectral irradiance is of critical importance for understanding climate variability, and to disentangle natural variations from anthropogenic climate changes.

SOHO, the comet finder

SOHO is providing new measurements not only about the Sun. On 5 August 2005, Toni Scarmato, a high school teacher from Calabria, Italy, discovered SOHO's 999th and 1000th comet. As of October 2006, the LASCO instrument has detected over 1200 comets, most of them so-called sungrazers. These comets pass by very close to the Sun and acquire a prominent tail as the Sun heats their icy cores. Over half of all comets for which orbital elements have been determined (since 1761) were discovered by SOHO, over 80% of those by amateurs accessing LASCO data via the Web.

The going has not always been easy

An unexpected loss of contact occurred on 25 June 1998. Fortunately, the mission was completely recovered in one of the most dramatic rescue efforts in space, and normal operations could be resumed in mid-November 1998 after the successful recommissioning of the spacecraft and all twelve instruments. Despite subsequent failures of all three gyroscopes (the last in December 1998), new gyroless control software installed by February 1999 allowed the spacecraft to return to normal scientific operations, providing an even greater margin of safety for the spacecraft. This made SOHO the first three-axis-stabilized spacecraft to be operated without a gyroscope. A third crisis occurred in June 2003, when SOHO’s main antenna became stuck. Using the secondary antenna and software for intermittent recording, however, even this problem could be overcome and the observations continue.

Conclusions and SOHO's future

In complex areas of research such as solar physics, progress is not made by just a few people. The scientific achievements of the SOHO mission are the results of a concerted, multi-disciplinary effort by a large international community of solar scientists, involving sound investment in space hardware coupled with a vigorous and well-coordinated scientific operation and interpretation effort.

In the 11 years since launch, SOHO has provided an unparalleled breadth and depth of information about the Sun, from its interior, through the hot and dynamic atmosphere, to the solar wind and its interaction with the interstellar medium. The coming years promise to be similarly exciting and rewarding, when SOHO observations will be complemented and enhanced by those from NASA's STEREO and JAXA's Solar-B missions, affording new opportunities for improved understanding of the Sun-heliosphere system. After the launch of NASA's Solar Dynamics Observatory, SOHO's lineal descendant, the capabilities of some SOHO instruments will be eclipsed, but not all. In particular the LASCO coronagraph observations and VIRGO total solar irradiance measurements will continue to be critical and unique contributions to the International Living With a Star (ILWS) program.

Acknowledgements

The great success of the SOHO mission is a tribute to the many people – too many to name here – who designed and built this exquisite spacecraft and these excellent instruments, to the engineers who brought it back from the dead (twice), and to the many people who diligently work behind the scenes to keep it up and running.

Bernhard Fleck, ESA
SOHO Project Scientist

Seeing Double: The STEREO Mission

Launched on October 26, the Solar TErrestrial RElations Observatory (STEREO) is the latest solar physics mission in space. It is also the third in a coordinated sequence of science missions within NASA's Solar Terrestrial Probes (STP) Program which focuses on understanding how the Sun's variability affects the solar system and life on Earth. The main objectives of the STEREO mission are to investigate the physical mechanisms behind the initiation and evolution of coronal mass ejections (CMEs) and to follow the propagation of CMEs through the heliosphere. STEREO will also study the mechanisms and sites of energetic particle acceleration and develop 3D time-dependent models of the magnetic topology, temperature, density and velocity of the solar wind between the Sun and Earth.

To accomplish these goals, the mission employs the unique strategy of remotely imaging the solar corona and heliosphere simultaneously by two almost identical telescope suites located on two spacecraft. One spacecraft will lead and the other will trail the Earth with a separation rate of about 22 deg/year. The two vantage points will permit the use of stereoscopic techniques to estimate the 3D morphology of solar structures (e.g., loops, streamers, CMEs) and the increasing separation will allow the employment of the techniques to structures of varying scales (small loops at the beginning and CMEs at latter stages of the mission).

Science Payload

Each STEREO spacecraft carries four experiments, which together will characterize the space environment from the Sun's corona to the Earth's vicinity using both remote sensing and in-situ measurements. The experiments are:

1. Sun–Earth Connection Coronal and Heliospheric Investigation (SECCHI) PI: R. Howard, NRL
2. In situ Measurements of PArticles and CME Transients (IMPACT) PI: J. Luhman, Univ. of California, Berkeley
3. PLAsma and SupraThermal Ion Composition (PLASTIC) PI: T. Galvin, Univ. of New Hampshire
4. STEREO/WAVES (S/WAVES) PI: J.-L. Bougeret, Paris Observatory

The SECCHI experiment (Howard et al., 2002) is a suite of optical telescopes that observe the entire inner heliosphere from the solar surface out to the vicinity of Earth. The telescopes are arranged in two packages (Fig. 1). The Sun-Centered Imaging Package (SCIP) consists of an EUV disk imager (EUVI) to observe the corona and upper chromosphere out to 1.7 solar radii (Rs), two white light coronagraphs (COR1 & COR2) viewing the corona from 1.5 to 15 Rs and a guide telescope. The Heliospheric Imager Package (HI) consists of two wide-field imagers that observe the heliosphere between the Sun and the Earth (from ~12 to >215 Rs). SECCHI is the main experiment of the STEREO mission responsible for the great majority of the mission science objectives. It comprises a very significant instrumentation advance with several "firsts" for a solar physics payload. It is the first instrument suite to (1) remotely image the corona from two viewpoints and (2) to view the heliosphere continuously from the corona to the Earth. By combining a very large field of view with the radio and in-situ measurements from STEREO as well as from other space- and earth-based assets, we expect to answer some important questions of the physics of CMEs. In a similar way we anticipate that SECCHI will provide pioneering observations of CMEs as well as other structures, such as loops, plumes, streamers, comets, etc., using stereo deconvolution techniques.

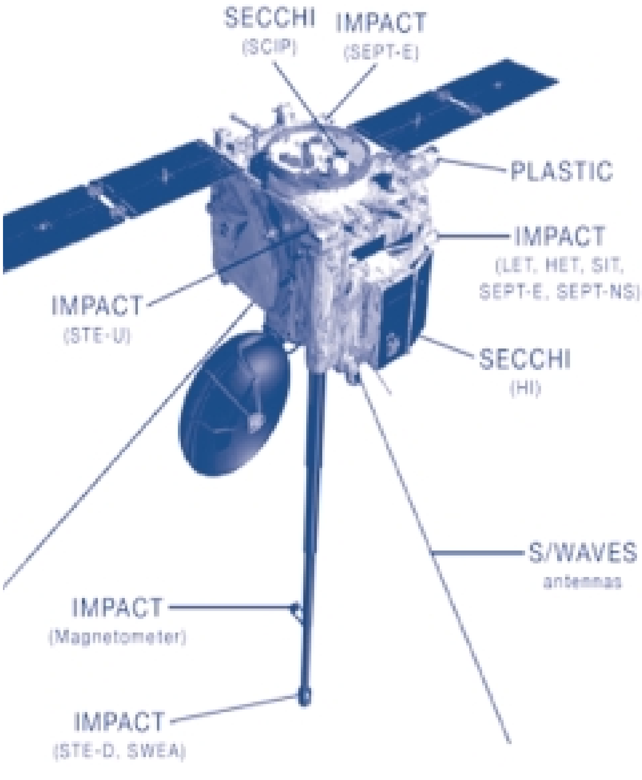


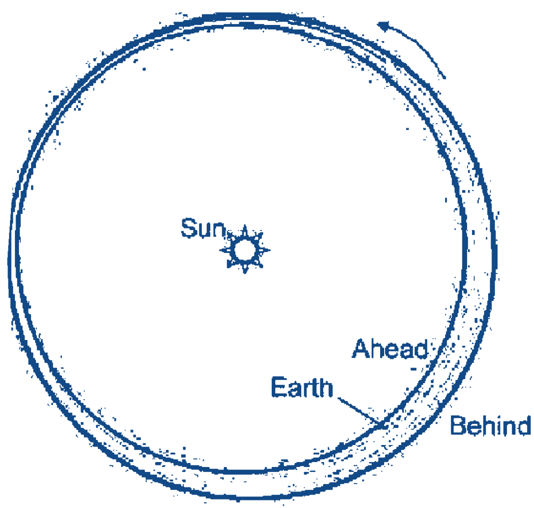
Figure 1. Science Payload on a the STEREO spacecraft

The IMPACT experiment (Luhmann et al 2005) is a collection of in-situ sensors to measure the interplanetary magnetic field, thermal and suprathermal solar wind electrons, and energetic electrons and ions. Three of the IMPACT instruments are located on a 6m deployable boom: (1) the Solar Wind Experiment (SWEA) measures 0.2–1 keV electrons, (2) the Suprathermal Electron Telescope (STE) measures electrons from 5 to 100 keV, and (3) the Magnetometer Experiment (MAG) measures the vector magnetic fields in the ±512 nT range with 0.1 nT accuracy. The remaining four IMPACT sensors are on the main spacecraft bus under the Solar Energetic Particle (SEP) Experiment Suite which includes the Suprathermal Ion Telescope (SIT), the Solar Electron & Proton Telescope (SEPT), the Low Energy Telescope (LET), and the High Energy Telescope (HET). These instruments will measure energetic particles in the following energy ranges electrons (0.02-6 MeV), protons (0.02-100 MeV), Helium ions (0.03-100 MeV/nuc), and heavier ions (0.03-40 MeV/nuc).

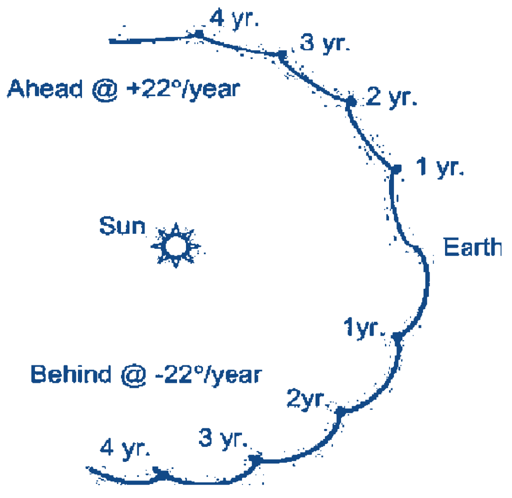
The PLASTIC experiment is an in-situ package to measure protons, alpha particles, and heavy ions. It focuses on measurements of the mass and charge state composition of heavy ions and can discriminate the CME plasma from ambient coronal plasma. PLASTIC has three in-situ sensors: (1) the Solar Wind Sector (SWS) proton channel measures the distribution functions of solar wind protons and alphas, providing proton density, velocity, kinetic temperature and its anisotropy, and alpha to proton ratios with a time resolution up to about 1 min, (2) the Solar Wind Sector (SWS) measures the composition, charge states, kinetic temperature, and speed of the more abundant solar wind heavy ions (e.g., C, O, Mg, Si, and Fe) with time resolution of about 5 min, for selected ions, (3) the Wide-Angle Partition (WAP) measures distribution functions of suprathermal ions, including particles accelerated at the shocks of interplanetary CMEs, recurrent particle events associated with Co-rotating Interaction Regions (CIRs), and heliospheric pickup ions. Typical time resolution for selected ions is several minutes to hours.

The S/WAVES instrument, built jointly by the Paris Observatory and the University of Minnesota, is a radio spectrometer that observes the generation and evolution of traveling radio disturbances from the Sun to the orbit of Earth. It is an evolution of the WAVES instrument aboard the Wind satellite. S/WAVES uses three 6m long monopole antenna elements and consists of three receivers: (1) the High Frequency Receiver (HFR and LFRhi) to measure intensity, source direction, and angular size of radio sources between 16 MHz and 40 kHz, corresponding to source distances from about 1Rs to 1 AU, (2) the Low Frequency Receivers (LFRlo) to make sensitive measurements of radio and plasma waves near the electron plasma frequency at 1 AU (2.5–40 kHz) and (3) a Fixed Frequency Receiver (FFR) at 32–34 MHz to provide a fiducial point with ground-based radio-heliograph measurements. Finally, S/WAVES has Time Domain Samplers (TDS) to simultaneously make wideband waveform measurements on the three antennas at several user-controlled sample rates and bandwidths.

Stereo "Ahead" and "Behind" spacecraft orbits



Heliocentric Inertial Coordinates
(Ecliptic Plane Projection)



Geocentric Solar Ecliptic Coordinates
Fixed Earth-Sun Line (Ecliptic Plane Projection)

Figure 2. The orbits of the two STEREO spacecraft

Operations

The main concept of the STEREO science operations is the simultaneity between the observations from the two spacecraft to maximize the accuracy of the stereoscopic reconstructions. This is especially important for the remote sensing SECCHI and S/WAVES telescopes where the light propagation time from the sun to the given spacecraft much be taken into account. The STEREO instruments, with the exception of SECCHI, have limited capability for special observing and will be operated on a synoptic mode for most of the time. The SECCHI telescopes can be operated on a variety of cadences, fields of view and sequences. However, the SOHO experience shows that synoptic observations are the best means to capture the CME evolution. The current plan is to devote about 80% of the SECCHI telemetry to a synoptic plan and dedicate the remaining 20% to special programs such as high cadence single wavelength EUVI observations.

The continuously changing separation between the two spacecraft naturally separates the mission objectives in 3 phases. During the early phase, the emphasis will be on reconstruction of small scale features using the EUVI telescopes. The in-situ instruments will have their best chance to make multipoint measurements of Earth-directed structures which will be imaged simultaneously by both HIs. By the end of the first year, the emphasis will shift to reconstruction of CMEs with COR1 and COR2 and towards the end of the mission, the two spacecraft will be at quadrature with each other allowing remote imaging from the SECCHI coronagraphs of the structures measured by the in-situ instruments on the other spacecraft. This phase offers the best viewing opportunity for the reconstruction of Earth-directed CMEs using the HI observations.

The STEREO data will be freely available to the science community as soon as they are received and processed by the instrument teams, usually within a day. In addition, the two STEREO spacecraft will broadcast continuously a low rate (~600 bps) data stream consisting of typically 1-min in-situ measurements and low-resolution SECCHI images for space weather forecasting. This data stream is known as the Space Weather Beacon and will be collected by NOAA and international ground tracking stations and send to the STEREO Science Center (see below) for processing. The goal is to make them available on the web within 5 min of receipt at the tracking stations. The main STEREO data sets can be accessed from the websites of the instrument teams or from the STEREO Science Center (SSC). The SSC is responsible for archiving and distributing the raw telemetry and for long-term science planning and coordination with the science teams. The SSC is the principal interface with the scientific community and the public at large and can be found at
http://stereo-ssc.nascom.nasa.gov.

To recap, the unique aspects of the STEREO mission offer exciting opportunities for understanding the physics of CMEs including several “firsts” such as:

- The first opportunity to obtain stereographic views of CMEs;
- The first opportunity to observe a CME in interplanetary space at the same time that in-situ measurements are made;
- The first opportunity to make simultaneous optical and radio observations of CMEs and shocks;
- The first opportunity to observe geo-effective CMEs along the Sun-Earth line in interplanetary space;
- The first opportunity to detect CMEs in a field of view that includes the Earth.

Status

After a textbook launch, the STEREO spacecraft separated successfully and are now (November 2006) undergoing engineering checkouts. All instruments are currently in nominal condition. The science observations will start about 90 days after launch when both spacecraft reach their final orbits. Regular updates are posted on the STEREO website (http://stereo.gsfc.nasa.gov). The solar physics community is looking forward to the upcoming STEREO observations, which along with the successfully launched Hinode spacecraft and the current large fleet of solar physics space missions (SOHO, TRACE, RHESSI, ACE, etc) will lead to a new era in heliophysics research.

More detailed information on STEREO can be obtained from the following documents

- The STEREO Mission: an Overview, M. L. Kaiser, Adv. Space Res., 36(8), 1483-1488, 2005.
- Sun Earth Connection Coronal and Heliospheric Investigation (SECCHI), R. A. Howard et al., Advances in Space Research, 29, 2017-2026, 2002.
- IMPACT: Science Goals and Firsts with STEREO, J. G. Luhmann et al., Adv. Space Res.,36(8), 1534-1543, 2005.

Angelos Vourlidas
SECCHI Mission Scientist