

BELGIUM: 2003 NATIONAL REPORT

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The Solar Physics Department of the Royal Observatory of Belgium (ROB) continued its development. Most of the solar physics research in Belgium is conducted in that institute (observation) and at the Catholic University of Leuven (plasma theory).

1 Royal Observatory of Belgium, ROB, Brussels

The main axes of activity at the ROB and the main achievements of 2002-2003 are the following:

1. The Solar Influences Data analysis Center (SIDC), world center for the Sunspot Index and Regional Warning Center of the ISES: the SIDC is now continuously improving the solar and geomagnetic activity forecasts. It strongly developed its Web and e-mail services (<http://sidc/oma.be>. More than 400 registered users). It also successfully submitted a proposal in the framework of the ESA Space Weather Pilot Project. This joint initiative with other research teams in Belgium (ROB geodesy, BISA, RMI) started in January 2003 and focuses on specific user products (e.g. GPS disturbances). It places the SIDC as the central solar data and forecast provider in Europe.
2. The development of space projects, mostly EUV imagers of the corona: the ROB contributes to the science analysis, the operations (observing campaigns), databases (archives, data selection and preprocessing), software development and participation to instrument design. Most of these projects are funded by the Belgian Ministry of Science Policy through PRODEX. The missions now in operation are:
 - EIT and LASCO on SOHO (Science Co-Investigators since 1991)
 - CORONAS-Spirit (data exploitation since 2003, collaboration with S. Kuzin, Lebedev Institute, Moscow)

New projects initiated over the last two years are:

- SECCHI on STEREO (Science co-Investigators, launch in 2006)
 - SWAP on PROBA2 (Science Principal Investigator, launch in 2006): single channel whole-disk EUV imager on a Belgian technological satellite developed for ESA.
 - LYRA on PROBA2 (Principal Investigator): multichannel UV irradiance measurements. SWAP and LYRA development started in mid-2003.
 - SHARPP on SDO (Co-Investigators, launch in 2008): high-resolution multi-wavelength coronal imager and coronagraph. This instrument was selected in August 2002, but cancelled during phase A in September 2003.
 - BOLD consortium (ESA funded): technological development of new EUV detectors that are blind to visible light and radiation hard.
 - Participation to the Solar Orbiter payload definition.
3. Research programs that are largely based on the exploitation of EUV images of the corona, in particular the full EIT archive, of which a copy is maintained at the ROB: global long-term statistical studies, event catalogs and velocity field studies. Most of those programs make use of advanced image processing techniques like wavelets, optical flow, image segmentation methods, automated detection and tracking of CMEs. This work is largely done in collaboration: Université Catholique de Louvain (Wavelets), Université de Paris-Dauphine (segmentation), Center for Plasma Astrophysics (KU Leuven), Kiepenheuer Institute & Hvar University (H. Wöhl, R. Brajša, solar rotation), Russian Institute of Nuclear Physics (Moscow, I. Veselovski)
4. Ground observing facilities operated by the ROB:
- The Uccle Solar Equatorial Table (USET): white light and $H\alpha$ patrol telescopes. Two CCD cameras have been in continuous operation since July 2002. The images are available on-line on the SIDC web site. Solar drawings are being digitized. The ROB visual observations span now a period of 80 years. A photographic archive (white-light and $H\alpha$) also exists and covers the period 1958 to 1980. By lack of resources, this material was never digitized.
 - The Humain radioastronomy station: the large 408MHz radioheliograph was turned off by mid-2002 by lack of resources to maintain this aging instrument. On the other hand, the measurements of the 600MHz flux continued and were made accessible on-line on the SIDC Web site. Finally, a 6-meter dish, that was so far unused, has been refurbished to install a modernized receiver, probably at 600MHz.

This will be developed through international collaborations. Contacts have been established in the sense with the Penticton (Canada) and Trieste (Italy) stations in the fall of 2003.

Following the multiplication of the new projects, the Solar Physics staff has grown from 16 to 26 people in about 18 months: 4 permanent scientific staff members (P.Cugnon (*Head*), F. Clette (*Head ad interim since September 2002*), D. Berghmans, R. Van der Linden), 11 scientists/postdocs (+7), 1 PhD student, 10 technical/administrative assistants (+3).

2 Center for Plasma Astrophysics, Katholieke Universiteit Leuven (KUL)

The CPA mission comprises the theoretical study of waves, instabilities, flows, shocks, heating, and acceleration of magnetic plasmas in the Sun (atmosphere, wind, etc.), other stars, galactic disks, accretion disks, magnetospheres, and thermonuclear fusion machines. The favourite subject is the Sun, as a showcase (Rosetta stone) for plasma behaviour in astrophysical objects.

Specific subjects are: absorption and refraction of solar p-modes by sunspots, generation, propagation, and dissipation of MHD waves in flux tubes, MHD instabilities in magnetic flux tubes in the solar wind, normal mode analysis of coronal structures, MHD theory and kinetic theory of the solar wind, CMEs, CME shocks, and the role of CMEs in space weather. In 2002-2003, special efforts were dedicated to the domain of space weather (solar wind modelling, CME onset and propagation, CME shock evolution, time dependent MHD simulations).

Team composition: 4 staff members (M. Goossens (*chairman*), S. Poedts, A. Debussche), 10 research fellows/postdocs, 7 PhD students.

Main national/international collaborations and visiting scientists: von Karman Institute, ROB, Scientific Computing research group (K.U.Leuven), Meudon (Paris), FOM (NL), and HAO (USA). In the PLATON (EC RTN), the CPA collaborates with St. Andrews (UK), FOM (NL), Bochum, Athens, and IAC Tenerife. Currently, there is a visiting professor: A. Rogava.

Large collaborative projects:

- “The Solar Drivers of Space Weather”, (ESA PRODEX, from January 1, 2001)
- “Plasma Astrophysics: Theory, Observations, and Numerics of Heating, Flares, and Winds” (PLATON, EC Research Training Network).
- “Current-driven instability of ion-cyclotron kinetic Alfvén waves: anomalous resistivity, fast magnetic reconnection, heating and acceleration of plasma in the solar atmosphere”, (FNRS/FWO project, leader: Marcel Goossens).

- “Multi-disciplinary Research on the Solar Drivers of Space Weather”, ‘Onderzoekstoelage’ (Onderzoeksraad-Research Council of the K.U.Leuven), 1/10/2002 – 30/9/2006).
- “Multi-disciplinary Research on the Solar Astrophysics” , (Onderzoeksraad-Research Council of the K.U.Leuven, 1/1/2004 – 31/12/2008).

3 Other Institutes

- Institut d’Astrophysique (IAL, Université de Liège): spectroscopy based on ground-based and space-based infrared solar spectra, in collaboration with the ROB Astrophysics Dept. (N. Grevesse, 1 scientist).
- Universitaire Instelling Antwerpen (UIA): solar magnetism and dynamo theory (D. Callebaut, 1 scientist).