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Solar Physics research in Spain is carried out at several Institutes and Universities, in Madrid, the Balearic Islands, Barcelona, and the Canaries. Our previous national representative Dr. José Carlos del Toro Iniesta, excellent colleague and friend, left the Instituto de Astrofísica de Canarias last July and moved to the Instituto de Astrofísica de Andalucía, in Granada. Hopefully, he will promote Solar Physics there in a near future.

1. Laboratorio de Astrofísica Espacial y Física Fundamental

At the *Laboratorio de Astrofísica Espacial y Física Fundamental* (*LAEFF*, Laboratory for Space Astrophysics and Fundamental Physics) in Madrid, work on a **theoretical explanation of the Evershed flow** has been concluded. This realistic penumbral model is based on the siphon effect and has proved to be compatible with a recent 3D sunspot model derived from observations by researchers of the IAC and HAO (see later).

2. Universitat de les Illes Balears

The Solar Physics group at the *Universitat de les Illes Balears* (*UIB*, University of the Balearic Islands) is involved in the following research topics:

- **Behaviour of solar activity:** the Hurst analysis of solar activity has been finished. It has been recently pointed out the possibility of predicting some energetic events, from the confirmation of a period of about five months present in the sunspot cycle, coincident with that of flare appearance.
- **Magnetohydrodynamics of coronal structures:** MHD waves in current sheets, resonant absorption of waves in coronal arcades, oscillations in prominences, and propagation of impulsively generated fast waves within the corona are studied.

3. Universitat de Barcelona

At the *Universitat de Barcelona* (*UB*, University of Barcelona), work is being done in the analysis and modeling of the interplanetary propagation of MHD shock-accelerated proton events.

4. Instituto de Astrofísica de Canarias

At the *Instituto de Astrofísica de Canarias* (*IAC*, Astrophysics Institute of the Canary Islands), Solar Physics research is organised in three projects: **Structure and dynamics of the solar atmosphere**, **Magnetism, radiation and fluids in Astrophysics**, and **Helioseismology**. **Instrumental development** is carried out at our Institute as well.

4.1. Helioseismology

This group is presently involved in the fully exploitation of data from the VIRGO and GOLF experiments aboard the SOHO satellite, as well as from the different instruments of the world-wide networks the Teide Observatory belongs to. The main recent results of their research are:

- **Parameters of p-modes of low degree** ($l < 7$) have been obtained with a precision never reached up to now. Frequencies and splittings of low l (< 4) and low n (< 10) oscillation modes have also been accurately measured for the first time.

A. Antalová, H. Balthasar and A. Kučera (eds.): JOSO Annual Report '98, 49 – 51

- **Oscillations above the cutoff frequency** have been detected for the first time using full disc measurements.
- The **Sun rotational profile** has been obtained from the base of the chromosphere down to 28000 km.
- **Meridional flows** from the solar equator to the poles have been found in the high layers of the convective envelope, using the ring diagrams technique and MDI/SOHO data.

4.2. Magnetohydrodynamics

This working line can be itemized as follows:

- Theoretical study and numerical simulation of **flux emergence** (in the form of twisted magnetic flux tubes) in the solar interior.
- Analysis of the **magnetic field influence on the solar oscillation modes.**
- **Non-linear diffusion of magnetic field**, with application to sunspots decay.
- In the framework of the **turbulence theory**, an analytical model of the overshooting layer has been presented.

4.3. Generation and transport of polarised radiation

The following items can be pointed out within this line:

- An adaptation of the original SIR (Stokes Inversion based on Response Functions) **inversion code** is being concluded to deal with spectropolarimetric data **under NLTE conditions.**
- The **NLTE simulation of spectral line formation** in 1, 2 and 3D media is also in progress, as well as the study of the generation of polarized signals due to scattering processes.

4.4. Plasma Physics

The work consists of studies of **MHD stability**, and developments of the **dynamo theory**, with future application to stars.

4.5. Inversion techniques and radiative transfer

The SIR code is being applied to different solar scenarios:

- The quasi-NLTE inversion of a time series of spectra has allowed to obtain the **stratification of the amplitude and phase of the temperature and velocity 5-minute oscillations** through the photosphere.
- From inversion of ASP data, the **optical tomography of a sunspot** has been obtained, providing an explanation of the Evershed flow.
- A **new Hermitian method** has been proposed and applied to integrate the Radiative Transfer Equation for polarized light in the fastest and more accurate way up to now.
- From an adaptation of SIR, incorporating this method, the inversion of facular ASP profiles under the thin flux tube hypothesis has been carried out. As a result, a **realistic flux tube model** has been presented, which explains the Stokes V asymmetries and zero-crossing wavelength shifts.

A distinct **inversion** is based in the **MISMA** (Micro Structures Magnetic Atmospheres) hypothesis, which also gives a quantitative explanation of the Stokes V asymmetries in faculae.

Finally, atomic alignment signatures in linear polarization spectra have been studied.

4.6. Photospheric and chromospheric structures

Within this research area, several topics can be mentioned:

- **Photospheric and chromospheric structures**: from high spatial resolution images, the centre-to-limb variation of granulation and faculae is being analysed.
- A study of **thermodynamical properties of granulation in quiet and active regions** is practically concluded, based on 2D spectroscopic data taken with the aid of the Correlation Tracker developed at the IAC.
- Other researchers are involved in the **analysis of sunspots and emergent active regions**, using ASP data.
- Concerning the chromosphere, work is in progress in the analysis of changes in the **polarity of sunspots and of CaII K bright points.**
- The **first IR data** have been obtained at our observatories, with simultaneous observations in 0.8 and 1.6 μ.

4.7. Solar variability

Both types of studies can be enumerated:

- On the one hand, the **daily energetic balance of active regions**, with an analysis of the granulation and photospheric network variability.
- On the other hand, the **cycle variability of the solar energy input**, its comparison to irradiance measurements from space, and possible relation to the Earth's climate.

4.8. Instrumental development

Finally, a number of members of these three projects at our Institute are deeply involved in the design, development and upgrading of solar instrumentation, in collaboration with the staff of the Electronics, Optics, Mechanics, and Software Engineering departments. Let me summarise the main results of their work, which can be considered good news for the solar community:

- **SAIS II:** the acronym stands for *Selector Automático de Imágenes Solares*, i.e., automatic selector of solar images. This is the second version of the instrument, improved with a new PC Pentium II, a high-speed framegrabber and a video camera Dalsa 1024×1024 px. The system has been successfully tested in June 1998 at the VNT of the Teide Observatory, where it will be regularly installed for a long-term observational program.
- **Upgrading of the VNT:** an IR camera (128×128 px) and a new pinhole photometer have been installed. In addition, an auxiliary telescope (6 cm) is now available, and full disc observations at six different wavelengths (blue, green and red broad-band, G band and CaII K) can be obtained with SAIS II. A daily CaII image is available at the Web:

  (http://www.iac.es/folleto/research/en3_87.html),

  which will be extended next year to the six mentioned filters.
- **Visible and IR Polarimeters:** these are two new-generation instruments based on ferroelectric liquid crystals. Both have been successfully tested very recently: the visible polarimeter (LPSP, La Palma Stokes Polarimeter) at the SVST of the Roque de los Muchachos Observatory in September 1998, and the IR one (TIP, Tenerife Infrared Polarimeter) at the VTT in Izaña in July 1998, and at the GCT in October 1998. Further improvements are being done at the moment and planned for next year.
- Finally, a **user-friendly version of the SIR code** will be available in the next months, to be used by anyone interested in.