2002/03 ACTIVITY REPORT FOR GERMANY

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1 The 1.5 m GREGOR Telescope Project

The telescope project GREGOR is a collaboration of the Kiepenheuer-Institute Freiburg (**KIS**), the Universitätssternwarte Göttingen (**USG**) and the Astrophysikalisches Institut Potsdam (**AIP**). The project management and supervision is done by the KIS. The Instituto de Astrofisica de Canarias (**IAC**) and the Astronomical Institute of the Czech Republic Ondrejov (**ASU**) are contributing with instrumental components.
GREGOR is an open, alt-azimuthal Gregory-Coudé with a prime mirror of 1.5m diameter, replacing the 45cm Gregory telescope at Izaña, Tenerife.
During 2002, the design of the instrument had been completed and construction of the main telescope components and a new dome were ordered. In 2003, the former GREGORY telescope and its dome were removed and the necessary reconstruction of the building was done. The blankets for the main mirror and several auxiliary mirrors, made from silicon-carbid, have been produced and will get their optical shape soon. Construction of the new dome and the mechanical structure of the telescope is under way.
Whereas the production of the main optical and mechanical parts were given away to commercial companies, several important components will be contributed by the associated institutes:

USG: – Water-cooled field-stop at the primary focus (status: designed, tested);
– Mounting of the secondary mirror M2 and adaption of a hexapod for optical alignment (status: in process);
– Fabry-Perot spectrometer (status: designed);
– Slit-jaw imaging assembly (status: designed).

ASU: Image de–rotator (status: under construction).

AIP: – Mounting of mirrors M3, M4 (status: under construction);
– Package for the calibration and modulation of the polarization measurements at GREGOR inside the telescope.

IAC: Grating spectrograph: adaption of the existing one;

For a detailed description of GREGOR and the actual status of the project visit the web-page `http://gregor.kis.uni-freiburg.de/`

2 Solar group at Astrophysikalisches Institut (AIP): Einsteinturm Potsdam, and Solar Radioastronomy Tremsdorf

2.1 Solar Observatory 'Einsteinturm'

Home–page: http://aipsoe.aip.de/

2.1.1 Technical developments

(see GREGOR project)

2.1.2 Observations

Observations were performed with the Tenerife Infrared Polarimeter (TIP) at the VTT to study the spatial structure and temporal behavior of the magnetic field in sunspots. The campaigns in 2003 were part of the European Solar Magnetism Network (ESMN 2).

2.1.3 Theory: Modeling and interpretation

Within the EU Network PLATON theoretical modeling considered 3-dimensional magnetic reconnection and its role in flare energy release as well as the evolution and instability of twisted coronal magnetic flux tubes; the model predictions have been compared with SUMER observations. The investigation of non-radial oscillations including long–period vortical eigen–oscillations in the solar interior and their influence on quasi–periodic solar and geophysical processes has been continued. A new procedure for nonlinear force–free magnetic field extrapolation from photospheric magnetic field measurements has been developed and tested (PLATON). A stochastic approach to polarized radiative transfer provided a new method for the diagnostics of turbulent, spatially unresolved but meso–scaled magnetic fields.

2.2 Observatory of Solar Radioastronomy in Tremsdorf

Home–page: http://www.aip.de/groups/osra/

2.2.1 Technical development

The radio radiation of the Sun is observed by a remotely working spectrometer in the range 40−800 MHz. For obtaining a maximum stability of the patrol observing program, the mechanics and electronics for the aerial guidance were renewed in 2002−2003.

2.2.2 Routine observations

The solar radio data are daily presented in time in the internet (http://www.aip.de/gorups/osra). Furthermore, the data are monthly published in "Solar Geophysical Data".
In connection with the NASA space mission RHESSI (Ramaty High Energetic Solar Spectroscopic Imager), solar radio data are offered to the RHESSI Experimental Data Center.

2.2.3 Research

The NASA satellite RHESSI is providing hard X–ray images of the Sun in the range 3 keV−17 MeV with an unprecedented spectral and spatial resolution. Processes accompanied with energetic electrons

in the corona are the main subject of research at the AIP, since energetic electrons are responsible for both hard X–ray and non-thermal radio radiation.
The flare occurred on June 2, 2002 has especially been studied with respect to RHESSI and radio observations. It could explicitly be shown, that a moving plasmoid drives a shock ahead itself. The electron acceleration a such shocks has theoretically been studied in detail an compared with the observations.

3 Kiepenheuer Institut für Sonnenphysik (KIS), Freiburg

Home-page: http://www.kis.uni-freiburg.de/

3.1 Technical developments

1. **POLIS:** The Polarimetric Littrow Spectrometer, installed at the VTT, has been improved and first scientific data have been taken. Simultaneous observations with the TIP have been tested and are now possible. This offers the unique possibility to perform simultaneous spectropolarimetry in the visible and in the infrared.
2. **Adaptive optics**: The KIS-AO system **"KAOS"** went in operation in 2002 and could successfully demonstrate its capabilities. The system is now under reconstruction to make it available for all post–focal instruments of the VTT. A Multi-conjugate AO system (**MCAO**) is under development for future use at the GREGOR telescope.
3. **Sunrise:** The stratospheric balloon telescope Sunrise is an international cooperation, led by the MPAE. The KIS participates with the development of a correlation tracker and wave-front sensor (CWS). The instrument is based on a 18-element Shack-Hartmann wave-front sensor. It will be perform automatic in-flight alignment and focusing of the telescope and high-precision guiding. During 2003, the instrument design was worked out. Fabrication and software development are planned for 2004 and 2005.

3.2 Observational work:

In each year, about 10 campaigns were carried out at the VTT with involvement of scientists of the KIS. Main topics were:
– Magnetic field and velocity in and around sunspots.
– Magnetic oscillations in sunspots.
– Dynamics of solar granulation and of active areas.
– G-band bright points.
– Small–scale chromospheric dynamics.
One of the observational highlights in 2003 was the transit of Mercury which was used to investigate instrumental effects and to test the performance of the AO–system. For the first time, the exosphere of Mercury has been traced above the planet's limb by its additional absorption in the Na D line.

3.3 Theoretical work:

– Numerical 3D-MHD calculations including radiative transfer, control of magnetic-field solenoidity, adaption to spherical geometry; anelastic approximation, convective overshooting, dynamos in fully convective stars.
– Mean field dynamo models: calculation of dynamo coefficients including *magnetic pumping* effect.
– Convection-oscillation coupling: Correction of p–mode frequencies by near–surface convection.
– MHD modeling of magnetic coronal funnels.

4 Max-Planck Institut für Aeronomie (MPAE), Katlenburg-Lindau

Home–page: http://www.linmpi.mpg.de/

4.1 Technical developments

The solar group at the MPAE is participating in several solar instrumentation projects:

- **SUNRISE:** Balloon-borne 1-m telescope for high-resolution solar observations.
- **STEREO:** Secchi instrument.

- **NEXUS:** High-resolution EUV spectrometer (NASA Smex).
- **GREGOR:** Upgrade of the German Gregory-Coudé telescope at Izana.
- **BOLD:** Active-pixel EUV-detector development.
- New radiometric calibration light source in the EUV and VUV spectral range.

4.2 Observing facilities in operation

The solar group at the MPAE is responsible for or involved in several instruments on **SOHO:**

SUMER: EUV spectrometer

LASCO: white-light coronagraph

CELIAS: particle instrument

4.3 Observational work and data analysis

The experimental activities of MPAE were mainly related to observations with the instruments on SOHO– SUMER and LASCO. The LASCO images can be found in near real time on the SOHO page or on the LASCO page http://star.mpae.gwdg.de/ . The recent SUMER observation of Doppler oscillations in hot coronal loops is a remarkable new result, which has initiated a major step towards coronal seismology.
In 2002/2003, 104 SUMER related papers have appeared in refereed journals and 53 papers have been presented at conferences (status Oct. '03). Bibliographic information can be found under
http://www.linmpi.mpg.de/english/projekte/sumer/text/papers.html

4.4 Theoretical work

- 3–D simulations of radiative MHD in the upper convection zone and lower atmosphere, comparison of observational results (group of Manfred Schüssler).

- 3–D kinetic simulation of boundary layers and reconnection in the solar corona and transition layer, comparison with observational results (group of Jörg Büchner).
- 3–D MHD simulation of shear flows and their consequences for chromospheric and transition layer energy release, starting from polarimetric observations and magnetic field measurements (group of Jörg Büchner).
- Theoretical work on plasma micro-instabilities in the solar wind and analysis of the data from the Helios plasma experiment, with respect to pitch-angle diffusion and kinetic instabilities driven by ion beams or temperature anisotropy (group of Eckart Marsch).

5 Solar department of Universitätssternwarte Göttingen (USG)

Home–page: http://www.uni-sw.gwdg.de/

5.1 Technical developments

5.1.1 Gregory-Coudé Telescope (GCT) at Izaña

The GCT, its spectrograph and its dome were dismounted in May 2002 to give way to GREGOR. On this occasion, an international workshop was held in Göttingen on 24.–26. July 2002 with 70 participants (2003, AN **324**, 283). Regarding contributions to the GREGOR project see chapter GREGOR above.

5.2 Observational work and data analysis

The "Göttingen" Fabry-Perot spectrometer allowed again spectroscopic and polarimetric observations of two-dimensional fields of view with high spatial resolution (better than $0.5''$). The results comprise short-period waves in the quiet Sun (2002, A&A **395**, L51), small-scale magnetic fields in the internetwork (2003, A&A **407**, 741) and the fractal dimension of magnetic structures (2003, A&A **409**, 1127). The analysis of spectro-polarimetric speckle observations from polar faculae allows to study their temporal evolution on

a 40 min time scale. Simultaneous observations of magnetic lines in the visible (with THEMIS) and in the IR (with TIP at the VTT) showed the co-existence of kilo-Gauss and weak magnetic fields of few hundred Gauss strength in the internetwork (2003, ApJ **597, L177**). G-band bright points were used as tracers of deeply-rooted giant convection cells beneath a sunspot. Radial outward drift could be detected up to 10 Mm distance. Spectroscopy of two quiescent prominences simultaneously from space and ground yields indication for the prominence- corona transition layer emitting lines from hot ions up to 0.2 MK and non-thermal broadening up to 50 km/s, while the visible emissions indicate 8000 K and < 8 km/s. Purely coronal lines from ions hotter than 1 MK show absorption in the prominences which increases at wavelengths below the Lyman-series limit, indicating additional absorption by hydrogen ionization.

6 Solar observing facilities in operation

Site	Longitude	Latitude	Height	Institute
Schauinsland near Freiburg	7°54' 15 E"	47°54'48 N"	1240m	KIS
Izaña, Tenerife (VTT)	16°30'37 W"	28°18' 9 N"	2386m	KIS, AIP,
	° ' "	° ' "	m	MPAE, USG
Einsteinturm, Potsdam	13° 3' 54 E"	52°22'48 N"	100m	AIP
Hainberg near Göttingen	9°58' 30 E"	51°31'32 N"	347m	USG

7 Solar Scientists and Students at AIP, KIS, MPAE, USG

7.1 Solar group at Astrophysikalisches Institut AIP (Einsteinturm Potsdam, and Solar Radioastronomy Tremsdorf)

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PhD students:
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Post–Docs:
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Guests, retired scientists, scientists on leave:
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Students of the International Max Planck Research School on Physical Processes in the Solar System and Beyond at the Universities of Göttingen and Braunschweig (IMPRS):
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7.4 Scientists of Solar Group at Universitätssternwarte Göttingen

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