PROPOSAL FOR OBSERVING PROGRAM 2006
for the Swedish 1-meter Solar Telescope (SST) and the Dutch Open Telescope (DOT)

Title of the program:	Spectroscopy and imaging tomography of the solar fibrils: photospheric drivers and coronal consequences
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Type of the program: SST spectroscopy and complementary DOT imaging tomography of the solar fibrils.

Targets: plages near active regions, internetwork and network of the quiet solar atmosphere; both near the disk center.

Cooperating instruments: the Swedish 1-meter Solar Telescope (SST) and the Dutch Open Telescope (DOT), (optionally also the TRACE satellite, the Coronal Diagnostic Spectrometer (SOHO/CDS), and the Michelson Doppler Imager (SOHO/MDI)).

Scientific objective: Drivers of the solar fibrils are planned to be investigated using the high spatial resolution spectra of the Doppler and Zeeman photospheric lines taken with the SST together with the DOT tomography of the chromospheric layers. Exploitation of the currently achieved high spatial resolutions of these instruments should provide not only further insight into the dynamics of the solar fibrils in the chromosphere but also the links between the photospheric velocity and magnetic fields and the fibrils. According to the spatial dimensions of the solar fibrils our observations require the highest possible spatial resolution. (Optionally the MDI/SOHO magnetograms are proposed to be used for further evolution of the magnetic fields in the vicinity of the selected target.) Utilization of the TRACE filtergrams and the SOHO/CDS spectra is planned to be performed to cover consequences of the fibrils in the transition region and low corona. The already tested SOHO/CDS procedure of the SOHO JOP 171 observing program[1] will be used for this purpose.

We expect that merging of the high cadence 2-D spectra from the SST with the time series of the speckle-reconstructed DOT filtergrams will provide significant added value for studying dynamics and reasons of the solar fibrils. Especially information derived from inversion of the

[1] http://sohowww.nascom.nasa.gov/soc/JOPs/jop171/

spectral profiles of the photospheric lines should allow to extend results of the recent research on solar spicules (DePontieu, Erdélyi & James, Nature 430, 536 (2004)). These information will contain dependence of the basic physical parameters like temperature, density, line-of-sight velocity and information on magnetic field strength on height in the photosphere. The consequences of the specific height stratification of the parameters could be followed by TRACE filtergrams and the SOHO/CDS spectra bringing some output on heating of the chromosphere and the transition region.

Hereafter the main details of our planned approach are explained:

(1) Simultaneous inversion of spectral lines using the SIR code enables to determine time evolution of the physical parameters through the whole photosphere. Comparison of profiles of the Doppler and the Zeeman lines allows also to estimate the magnetic field strength using the SIR code. Therefore the Zeeman Fe II line 6149 Å line with no linear polarization and the 'classical' pair of 6301/6302 Å lines have been selected together with the Doppler 5576 Å line. These lines will be inverted in order to provide data on temporal and spatial development of granules and intergranular lanes beneath the observed fibrils. The main argument to try to acquire new data at the SST and the DOT together is to pool together the spectroscopic data from the SST with the DOT filtergrams derived from the tuned Hα filter, Ca II H line core filter, and from the G-band filter. Other argument is to get the time coverage of measurements up to 60 minutes at least keeping the spatial resolution at the required very high level.

(2) Besides these main goal described above we have in mind to investigate consequences of the solar fibrils in the transition region and low corona. The latest TRACE results show that the TRACE satellite can acquire data needed for tracing dynamics of the coronal loops. Additionally the transition region emission can be traced using the C IV emission adequately by TRACE. Co-spatial and co-temporal measurements of the SST, DOT and TRACE should help to understand what sorts of the magnetic and/or dynamic phenomena in the photosphere are the solar fibrils and the oscillations of the coronal loops connected to. Additionally is there a coupling between the solar fibrils and longitudinal oscillations of the coronal loops and/or enhanced transition region emission respectively? The CDS spectroscopy, although of the low spectral resolution, provides a perfect temperature coverage of the line emission from chromosphere up to the corona. Therefore questions on the photospheric sources of the chromospheric and coronal heating and dynamics in the quiet solar atmosphere could be addressed.

Time allocation request:

Number of days needed: min - 7, max - 14
Preferred time: no preferred time
Impossible time: none

Observing procedures and requirements:

SST:

- telescope: AO and correlation tracker

- spectrograph: standard grating and 2-3 prefilters for the selected spectral ranges

- SJ system: simultaneous imaging of the slit-jaw FOV in the continua nearby the selected spectral ranges and in Ca II H line (using a dichroic mirror placed in front of the spectrograph)

- Detectors: 4 Megaplus 1.6(i) cameras (2 for spectra, 2 for SJ continua), 1 Megaplus II camera (spectrum at port C), 1 Megaplus 6.3 camera (Ca II H slit-jaw), in case that the Magaplus II cameras will not work properly in year 2006 we can rely just on two 1.6i cameras placed at the ports A and B.

- Observing procedures: sequential scanning of a very narrow 2-D area (∼2-3"wide) for at least 60 minutes with a cadence of ∼1 min per one raster of the area; 'save-all' mode for all scientific cameras triggered by one selected SJ camera

- Selected spectral lines:

Spectral range	Spectral lines
port A – 6301 Å	Fe I 6301.508 Å, Fe I 6302.764 Å, Fe I 6303.467 Å,Ti I 6303.7619Å
port B – 5576 Å	Fe I 5576.100 Å (g=0), Fe I 5577.028 Å, Ni I 5578.729 Å
port C – 6149 Å	Fe II 6149.249 Å (no linear polarization), Fe I 6151.623 Å

DOT:

As the main goal we plan to acquire five-wavelength profile sampling for H α line providing Dopplergrams for the chromospheric layers using tunable filter available at the DOT for this line. We expect to use also fixed filters for the blue and red continuum channels as well as G-band and Ca II H channels. The resulting speckle-restored image sequences for the FOV of 90" x 70" with cadence of 30 seconds completely satisfy our demands on spatial and temporal resolution. Compensation for the solar rotation is needed during the DOT observing runs. Final co-alignment with the SST (and TRACE data) will be performed using the white light images.

Application for the DOT support is submitted in parallel to the SST proposal. We apply for the external usage of the DOT in a service mode in which the DOT team operates the telescope.

TRACE (optionally):

The TRACE support will be requested only when our SST and DOT observing period will be scheduled. In particular we are interested in the high resolution images (0.5") taken in the white light (WL), UV 1600 Å continuum, C IV 1550 Å, Lyman α and Fe IX 171 Å channels. Expected exposure times are 4, 2, 2, 0.2, and 45 sec respectively and cadence of 1 set of these exposures per 1 minute can be reached. The white light images will be used for the post-facto co-alignment with the SST slit-jaw images and the DOT images.

SOHO/(CDS+MDI) (optionally):

We intend to apply also for supporting observations of two space-born instruments – SOHO/CDS and SOHO/MDI.

SOHO/CDS: 1-D measurements in center of previously taken 2-D raster are planned using the spectral lines forming over an extended temperature range: He I 584.33 Å (2×10^4K), O III 599.59 Å (8×10^4K), O V 629.74 Å (2.5×10^5K), Ne VI 562.80 Å (8×10^5K), Mg IX 386.04 Å (1×10^6K), and Si XII 520.67 Å (2×10^6K). Exposure cadence of only 10 s is sufficient to trace possible variations of emission and dynamics of the outer solar atmosphere (e.g., Gömöry et al. 2006).[2]

SOHO/MDI: high-resolution longitudinal magnetograms (0.6") of the 1-min cadence will be acquired with some intensitygrams. These data will be used for tracing evolution of the photospheric magnetic flux within the FOV of the SST and the DOT. The WL intensitygrams will be used for post-facto coalignment of the MDI, TRACE and images from the SST and the DOT.

Additional information:

ESMN: This application for the SST+DOT observing time is partly prepared also as training of young students in the frame of the ESMN program. Reduction and interpretation of all data obtained from the involved instruments will be a part of training of PhD students in frame of the ESMN program.

MULTIDOT: This application is closely related to the EU MC fellowship named MULTIDOT with which one of proposers - J. Koza - has been granted for the period of 2 years starting last summer. The topic of the project is 'Solar fibrils and spicules at high resolution' and it is hosted by the Sterrekundig Instituut in Utrecht (The Netherlands).

TRACE and SOHO/(CDS+MDI) support: The TRACE, CDS and MDI parts of the SOHO JOP 171 led by Peter Gömöry is proposed to be optionally operated during the SST+DOT observations in order to track evolution of the context photospheric magnetic fields, transition region and low corona. This TRACE, CDS and MDI program has been already run but only very limited DOT support (just few minutes) was acquired in the year 2005.

Team experience with the SST – October 2004: This proposal is in fact a re-application of the previous one which was granted by the SST+DOT observing time for October 2005. Unfortunately, weather and seeing conditions were so bad that no high quality data were acquired. Only some good individual snapshots were taken on Oct 19 and 22, but such material is not satisfactory for our specific scientific goal. More detailed notes on our SST campaign, held in October 2005, are available at `http://www.astro.sk/~choc/05_campaign/05_campaign.html`.

Nevertheless our team has got very good experience with the SST operation including its CT, AO and the spectral science cameras. Additionally, the proposal is adapted according to our knowledge we have learned directly at the SST. In particular it was recognized that the scanned area width has to be limited to less than 3" width, the 'save-all' mode was identified as the most appropriate mode for data acquisition, selection and position of the science cameras was made.

[2] A&A in press, see `http://www.astro.sk/~choc/publications/grkcw_aa_2006/grkcw_aa_2006.html`