PROPOSAL FOR OBSERVING PROGRAM 2005 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: complementary SST spectroscopy and DOT imaging tomography of the solar fibrils.

Targets: plages near active regions, internetwork and network in the quiet solar photosphere, both near the disk center.

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

Scientific objective: Photospheric drivers and coronal consequences of the solar fibrils are planned to be investigated using the high spectral resolution spectra of the Doppler and Zeeman photospheric lines using the SST together with the DOT tomography of the chromosphere. Exploitation of the currently achieved high spatial resolutions of these instruments should provide not only further insight into 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. (Optional utilization of the TRACE filtergrams and the CDS/SOHO spectra is planned to be performed to cover consequences of the fibrils in the transition region and low corona.)

We expect that merging of the high cadence 2D spectra from 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 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 height dependence of the basic physical parameters like temperature, density, line-of-sight velocity and information on magnetic field strength in the photosphere. (The consequences of the specific height stratification of the parameters could be followed by TRACE images and

the 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 together with the data from DOT is to pool together the spectroscopic data and blue spectral range imaging (continuum, Ca II H, G-band) from the SST with filtergrams derived from the tuned Hα filter from the DOT. Other arguments are to the time coverage up to 60 minutes at least keeping the spatial resolution at the required very high level.

(2) Long time series of spectra allow to separate the 5-min velocity signal from dynamics or thermodynamics of the granulation. The relation of 5-min oscillations to fast morphological changes of the photosphere as well as relation to the appearance of the solar fibrils can be studied including the vertical stratification of the oscillations. Our aim is to acquire 2D sequential data of the selected spectral lines which will be used for this task. Generally, the basic question where is the origin of the acoustic flux shall be addressed using spectral measurements via 2D scanning with the spectrograph slit. In particular the continuum intensity, vertical motions (Doppler velocity) and turbulence (line width) will be compared using several lines sampling different photospheric layers.

(3) Besides these main goals 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, can provide 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 in Ca II H, G band, and nearby continuum using a dichroic mirror placed in front of the spectrograph

- Detectors: 2 Megaplus 1.6 cameras (spectra), 4.2i/10 camera (slit-jaw)

- Observing procedures: sequential scanning of a narrow 2D area (∼10"wide) for at least 60 minutes with cadence of ∼1 min

- Selected spectral lines:

Sp. range	Spectral lines
6149 Å	Fe II 6149.249 Å (no linear polarization), Fe I 6151.623 Å
6301 Å	Fe I 6301,.508 Å, Fe I 6302.764 Å, Fe I 6303.467 Å,Ti I 6303.7619Å
5576 Å	Fe I 5576.100 Å (g=0), Fe I 5577.028 Å, Ni I 5578.729 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 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 (with some training of our students on the site in the frame of the ESMN EU project).

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.

Additional information:

ESMN: This application for the DOT observing time is partly prepared also as training of young students in the frame of the ESMN program. The proposers - members of the ESMN – plan to observe at the SST and the DOT asking also for the OPTICON programme support. Reduction and interpretation of all data obtained from the involved instruments will be also 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 this summer. The topic of the project is 'Solar fibrils and spicules at high resolution' and it will be hosted by the Sterrekundig Instituut in Utrecht (The Netherlands).

TRACE and CDS/SOHO support: The TRACE and CDS part of the SOHO JOP 171 led by Peter Gömöry (http://soho www.nascom.nasa.gov/soc/JOPs/jop171/) is proposed to be optionally operated during the DOT+SST observations in order to track evolution of the transition region and low corona also spectroscopically. This TRACE and CDS program has been already run but only very limited DOT support (1 day) was acquired in the year 2004.