OBSERVING TIME PROPOSAL FORM May 2015
for the 1.5 m solar telescope GREGOR
at the Observatorio del Teide, Tenerife, Spain

Please send the completed form by email to: `EAST_TAC@kis.uni-freiburg.de` .

Deadline: 6 March 2015

For retrieving this form consult:

`http://www.astro-east.org/index.php?id=533`

and for information on GREGOR consult:

`http://www.kis.uni-freiburg.de/index.php?id=167\&L=1`

For questions please contact R. Schlichenmaier: `schliche@kis.uni-freiburg.de`

1 Applicants

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Title of Project: Topology and physical parameters of the magnetic fields in solar filaments.

2 Justification

Scientific Objectives of Observing Time

(Please give a statement of the scientific objectives of the requested observing campaign and describe your observing plan in some detail (instrument, spectral line, other instrument specific details). Please make sure that all necessary information is provided.)

Filaments are elongated dark ribbons observed at the solar disk mainly in the chromospheric lines of hydrogen or helium such as Balmer-lines of neutral hydrogen or the He II 304 Å EUV line. Filaments seem to be dark against the bright solar disk in these lines due to scattering of chromospheric radiation in their plasma composed mainly of hydrogen and helium. Filaments can be described as clouds of relatively cool plasma suspended by the magnetic field above the solar surface. They occur in the quiet Sun as well as in active regions. In the quiet Sun, they are related to a weak magnetic field of the order of 10 G (e.g., Leroy et al., Solar Phys. 83, 135, 1983). In active regions, the inferred magnetic field strength inside filaments can reach up to 600 - 700 G (Kuckein et al., A&A, 501, 1113, 2009; Kuckein et al., A&A, 539, A131, 2012). A property common to all types of filaments is that they lie above the so-called polarity inversion line, an imaginary line that separates opposite polarities of the magnetic field on the solar surface. In fact, magnetic fields play a key role in all physical processes of the formation and evolution of filaments. Therefore, a better knowledge of the magnetic field in solar filaments is crucial for their complex physical understanding. One of the still open questions is how the magnetic field in the solar photosphere below filaments connects to that in the chromospheric and coronal part of the filament. The answer to this question is important to understand what leads to filament destabilization and subsequent eruptions and coronal mass ejections (CMEs) which have a high impact on space weather.

Therefore we propose a coordinated observing campaign to investigate the magnetic field configuration of solar filaments. We plan to combine observations acquired with the GREGOR telescope in Tenerife with simultaneous observations taken with the Coronal Multichannel Polarimeter for Slovakia (CoMP-S) operated at Lomnicky Peak Observatory (infrastructure obtained from the Structural Funds of EU) and spectrographs HSFA2 (HorizontalSonnenForschungAnlage No.2) and SLS (Solar Laboratory Spectrograph) operated at the Ondřejov observatory in Czech Republic.

The CoMP-S is a 2D multi-channel spectro-polarimeter attached to a 200/3000 ZEISS coronagraph, but with a neutral filter, measurements on the solar disk are also possible. The observations performed with CoMP-S will cover areas large enough to enclose the whole filament, and we plan to take the data in three spectral lines (Hα 656.3nm, He D3 587.5 nm and Ca II 854.2 nm) that probe different temperature regimes in the filament.

The HSFA2 and SLS spectrographs are multi-camera spectrographs with horizontal optical design fed by coelostats. They can scan small areas on solar disc or off-limb and provide simultaneous spectroscopic data in several chromospheric spectral lines. Both spectrographs are equipped with the Hα slit-jaw system. Using these spectrographs we plan to obtain spectra in the Hα, Hβ, ionised Calcium H line (Ca II 396.8 nm), infrared ionised Calcium line (Ca II 854.2 nm), and D3 (He I 587.5 nm) spectral line in several slit position across a filament.

With GREGOR we will scan areas at filaments and in deep layers of the solar atmosphere with high spatial resolution. We plan to acquire high-resolution IR spectro-polarimetric data recorded with the GRIS spectrograph. We would like to use GRIS in the 1μ window to obtain all four Stokes profiles of the Helium IR triplet (wavelengths around 1083 nm) and photospheric lines Si I 1078.6 nm and Fe I 1078.3 nm scanning a field of view 40 arcsec $\times$ 60 arcsec, requiering a total time of about 30 minutes. We are aware that switching between these two spectral ranges requires new flatfield and calibration (even they are very close in wavelength). Therefore, we do not plan to do it frequently. In addition, we would like to acquire high resolution images in the Ca II H and G-band using the blue imaging channel (BIC). We also plan to use slit-jaw system of the telescope.

Polarimetric data of the helium infrared triplet acquired with the GRIS at GREGOR will be used to estimate magnetic field in a filament using the HAZEL (HAnle and Zeeman Light) computer code. Subsequently, the estimated magnetic field will be taken as an imput parameter for a prominence magneto-hydrostatic equilibrium of Kippenhahn-Schlüter type (see e.g. Gunár et al., A&A, 567, A123, 2014 and references therein) in the 2D NLTE model of filament to simulate profiles of hydrogen balmer lines observed by the Ondřejov spectrographs and the CoMP-S instrument. This will allow us to estimate physiscal parameters of the filament plasma such as temperature, presure, density, etc. The data from ground-based instruments will be complemented by EUV observations of the AIA (Atmospheric Imaging Assembly; Lemen et al., Sol. Phys., 275, 17, 2012) instrument onboard the SDO satellite at wavelengths 304 Å and 193 Å. These satellite data will be used for study of absorption of the EUV coronal radiation from beneath the filament plasma at resonance continua of hydrogen and helium similarly as it was done for prominences by Schwartz et al. (A&A, 574, A62, 2015). Spectropolarimetric observations in photospheric lines obtained with the GRIS at GREGOR (i.e. in the above mentioned Si I 1078.6 nm and Fe I 1078.3 nm spectral lines) will be used for study of surface magnetic field under a filament using the SIR (Stokes Inversion using Response functions) inversion code.

This proposal is related to the project 'The magnetic vector field of solar filaments' supported by the DAAD in the framework 'Program Projektbezogener Personenaustausch Slowakei' (AIP/AISAS).

3 Observing requests:

Amount of days requested: 10

Impossible Dates:

(An attempt will be made to accommodate your "impossible time" in the schedule. There is absolutely no guarantee for success of this attempt.)

None.