Request for IRIS coordinated observations with the Swedish 1-meter Solar Telescope (SST) for the period 11–19 May 2016

1 Applicants

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2 Science rationale

Title of project: Waves in fine-scale structures of the solar chromosphere

Type of the observing program: Simultaneous CRISP and IRIS imaging spectroscopy of chromospheric on-disk fine-scale structures in Hα, Ca II 8542 Å, and IRIS spectral lines.

Scientific objectives:

The main goal of the observing program is to acquire data for detailed study of waves in chromospheric fine-scale structures combining high resolution Hα and Ca II 8542 Å imaging spectroscopy obtained by CRISP with the data obtained simultaneously by IRIS and SDO. The main objectives of the proposed project are:

(1) Identification and classification of MHD wave modes

While De Pontieu et al. (2014) showed a prevalence of torsional motions; our aim is to acquire data allowing also an identification of possible kink, sausage, and Alfvén waves. We will try to quantify their contribution to the total wave energy flux heating the upper solar atmosphere. Combining CRISP Hα and Ca II 8542 Å imaging spectroscopy with the IRIS high-resolution UV spectrometry and imagery will allow reliable crosscheck of identified MHD wave modes and their properties. Final data products will undergo an extensive survey with an aim to detect particular MHD wave modes.

Principles of detection of torsional Alfvén waves were described in Zaqarashvili (2003) and Zaqarashvili and Murawski (2007). They suggested that this wave mode can be identified through periodic variation of non-thermal broadening of a spectral line. The method was

applied in Jess et al. (2009) announcing a detection of chromospheric Alfvén waves seen as periodic variations of the Hα line width but without any significant changes of the line minimum intensity. Kink modes can be detected either as periodic variations of spectral line Doppler shift measured along a particular fine-scale structure (Kukhianidze et al. 2006) or in imagery as transverse displacement of a waveguide (Pietarila et al. 2011). The recent theoretical study by Goossens et al. (2014) demonstrates that kink waves do not only involve purely transverse motions of solar magnetic flux tubes, but the velocity field is a spatially and temporally varying sum of both transverse and rotational motion. Sausage mode reveals itself as periodic variations of cross-section of a waveguide anti-correlated with intensity variations measured along cross-section (Morton et al. 2012).

(2) Chromospheric magnetoseismology

Observed and theoretical properties of the waves will be used in estimating the plasma parameters in fine-scale structures. For example, observed periodicity and spatial scale (wavelength) of MHD kink waves can be used in estimating the magnetic field strength (Zaqarashvili et al. 2007). Energy flux carried by different wave modes will be estimated and compared to the requirements of chromospheric/coronal heating.

(3) Kelvin-Helmholtz instability in rotating magnetized jets

Axial motion and/or rotation of magnetic flux tubes lead to the velocity jump at the tube surface, which may eventually results in the Kelvin-Helmholtz instability (KHI) under some circumstances. Kink and torsional Alfvén waves have jumps of azimuthal velocity near the boundary; therefore they could be unstable to KHI. The energy of the waves could dissipate and heat the ambient plasma through the Kelvin-Helmholtz vortices. We will quest for KHI in chromospheric fine-scale structures combining CRISP imaging spectroscopy in the Hα and Ca II 8542 Å lines with the IRIS high-resolution UV spectrometry and imagery.

References

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3 Target, desired roll angle

Target: an enhanced network in the vicinity of small sunspots or evolved pores providing adequate contrast for AO of SST and facilitating co-alignment of Mg II w SJIs with SST and SDO data. Our objectives need targets not obscured by coronal loops or a thick coronal haze.

Desired position angles: the position angles μ between 1.0 (disk center) and 0.7

Solar rotation tracking: ON

Desired roll angle: The nominal roll angle of 0°, i.e., the IRIS slit is parallel to the N-S axis on the Sun, suffices for the requested program.

4 Requested day/time and duration

We request daily IRIS support in the period from 11 to 19 May 2016, including, preferably in a time period when IRIS is off the South Atlantic Anomaly. Since during those days the Sun rises at ORM at about 06:20 UT, we would like to get IRIS support in the morning hours, preferably from 07:30 UT till 12:00 UT, when there is a high probability of good seeing without interfering caldera clouds. If approved, we would like to perform daily the following sequence of OBS-IDs:

07:30 – 09:00 UT: 3640086436
09:00 – 10:30 UT: 3640086423
10:30 – 12:00 UT: 3600090404

5 Other participating instruments

CRISP at SST will be a leading instrument of the campaign. SDO/AIA and SDO/HMI data obtained on a regular basis will be employed in analysis.

6 Key constrains and a suggested OBS-ID

Key constrain for accomplishing our scientific objectives are:

- high cadence of both slit jaw images (SJI) and spectra obtained during a period of one hour or longer,
- large field-of-view to get statistics over a large region.

Besides sit-and-stare mode we request also for dense and sparse rastering of relatively narrow area with an aim to catch waves propagating along target fine structures. We request "Large Linelist" for the long-exposure sit-and-stare OBS-ID 3600090404 to cover also spectral lines emitted by hot plasma of small-scale explosive events which may occur in the target area. Their observation and analysis is a side program to our main objectives. In the following we detail our suggested OBS-IDs:

OBS-ID	3640086436
Description	Large dense 16-step raster 5″ × 120″ Si IV Mg II h/k Mg II w s Deep×4, "Spatial×2, Spectral×1", Small Linelist
DataRate (Mbit/s)	0.6
Step (s)	5.2 ± 0.1
Raster (s)	82.4 ± 0.1
SJI 1400 (s)	14.1 ± 5.4
SJI 2796 (s)	10.3 ± 0.1
SJI wing slow (s)	41.2 ± 0.0

OBS-ID	3640086423
Description	Large coarse 4-step raster 6″ × 120″ Si IV Mg II h/k Mg II w s Deep×4, "Spatial×2, Spectral×1", Small Linelist
DataRate (Mbit/s)	0.6
Step (s)	5.1 ± 0.1
Raster (s)	20.5 ± 0.2
SJI 1400 (s)	12.5 ± 4.7
SJI 2796 (s)	10.2 ± 0.1
SJI wing slow (s)	61.5 ± 0.0

OBS-ID	3600090404
Description	Very large sit-and-stare 0.3″ × 175″ Si IV Mg II h/k Mg II w s Deep×15, "Spatial×2, Spectral×1", Large Linelist
DataRate (Mbit/s)	0.6
Step (s)	16.5 ± 0.1
Raster (s)	16.5 ± 0.1
SJI 1400 (s)	40.2 ± 14.6
SJI 2796 (s)	32.9 ± 0.1
SJI wing slow (s)	197.5 ± 0.0

7 Contact info

The e-mail addresses of team members, who will perform on-site observations at SST are following:

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Usually J. Koza, keeping in mind IRIS day-to-day operations, will send daily in sufficient advance exact timing and targeting the SST observations to the IRIS planner.