JOP 061: Brightenings, flows & waves (SUMER, CDS, EIT, MDI)

Contributors: I. Rüedi, S.K. Solanki, K. Stucki, A. Brković (ETH Zürich),
U. Schühle (MPI, Lindau), R. Harrison, A. Fludra (RAL),
T. Hoeksema (Stanford), J. Gurman (NASA/Goddard),
M.C.E. Huber (ESA/SSD)

Scientific Justification

The chromosphere, transition zone and corona of the Sun are known to be highly dynamic on time scales of seconds to the solar cycle. Although the dynamics of these layers have been studied in the past, older UV observations were often hampered by limited spatial resolution, and limited spatial and/or temporal sampling. The SUMER and CDS instruments on SOHO have greatly extended the capability to measure time variability of UV emission at high spatial resolution, with a high cadence and over a relatively large spatial area.

In the present JOP we propose to observe long time series with high temporal resolution in a number of lines using primarily the spectrographic instruments SUMER and CDS, with important support from MDI magnetograms and EIT images. One of our aims is to study brightenings of extremely short-duration, such as those seen by Porter et al. (1984). We want to establish their frequency, spatial location, relation to longer-term changes in brightness, association with flows, waves and with magnetic patterns (or their evolution).

We are also interested in questions such as the relative amount of energy in the form of kinetic and thermal energy as a function of temperature. Or which fraction of the kinetic energy is in turbulent motions, waves, flows, or aperiodic pulses, etc.

The dynamics, like the time-averaged brightness of the solar upper atmosphere, depends strongly on the amount of magnetic flux. Thus, sunspots show different dynamic phenomena from plages, which differ again from the quiet Sun. We propose to observe all 3 types of features with as similar settings as possible in order to carry out a comparative analysis.

Instrumental considerations

The prime targets of the JOP are the quiet Sun at or close to the centre of the solar disk, as well as an active region that is in the process of crossing the central meridian. If possible the active region should include a sunspot, or at least large pores. The location of the regions to be observed, i.e. near the central meridian is dictated by the restricted mobility of the SUMER slit. The SUMER and CDS slits are to be aligned N/S and to be co-aligned as far as possible. To be certain that both instruments are indeed seeing the same solar region we propose to make CDS movies with an open slit, at least in the quiet sun. At the beginning and end of each time series we intend to observe the He I 584Å line with both

CDS and SUMER in order to test and possibly improve the co-alignment. Time series of a single solar region are to be taken over 10 hours with SUMER and CDS. Solar rotation is to be compensated. Total running time of this JOP is 4×10 h, with 2 time series each in the quiet and the active Sun. We also propose a 2 hour test run a few days beforehand to test the observing sequences, so that they can be improved before the main observations, if necessary.

High resolution MDI magnetograms of the regions under study will be of great value for determining the relationship of the brightenings to the underlying magnetic field.

EIT images will help to show the relationship to the hotter coronal plasma.

References

Porter et al., 1984, *Astrophys. J.* **220**, 643–665.

Operational sequence

The ideal period for observing is Weeks 17, end of week 16 and beginning of week 18 of 1997 (16th of April - 30th April). Note that I. Rüedi will be SUMER planner in Week 17. Ideally, we would like to perform only the 2 hours test run at the end of week 16 and the actual observations during week 17 and if necesssary beginning of week 18. If no active region crosses the meridian in this time, we would like to run the active-region sequences at a later date (preferably Week 18; if that is not possible, then after the SUMER pointing returns to the central meridian).

SUMER quiet sun sequences:

Initial pointing:	Sun centre
Step size:	no rastering
Pixels per spectral line:	120×50 (or 25)
Compression:	Quasilog (compression type 5)
Solar rotation compensation:	yes
Co-operation requirements:	copointing with CDS

Sequence 1:

Spectral lines:	O I 1302.17 Å (refpix 900), O I 1306.03 Å, Si II 1309.28 Å, N I 1318.99 Å, C II 1334.53Å
Slit:	1.0×120 arc sec^2 (slit 3)
Integration time:	15 sec
Duration of sequence:	5 hours

Sequence 2:

Spectral lines:	O V 629.73 Å, C I 1267.60 Å(refpix 733)
Slit:	1.0×120 arc sec^2 (slit 3)
Integration time:	15 sec
Duration of sequence:	5 hours

Sequence 3:

Spectral lines:	He 584.33 Å(refpix 250), O I 1152.15 Å, C III 1175 Å,
Slit:	1.0×120 arc sec^2 (slit 3)
Integration time:	15 sec
Duration of sequence:	5 hours

Sequence 4:

Spectral lines:	H I 1025.72 Å(refpix 245), O VI 1031.91 Å
Slit:	0.3×120 arc sec^2 (slit 6)
Integration time:	15 sec
Duration of sequence:	4 hours 15 min.

Sequence 5:

Spectral lines:	H I 1025.72 Å(refpix 230), O VI 1031.91 Å
Slit:	1.0×120 arc sec^2 (slit 5)
Integration time:	2 sec
Duration of sequence:	45 min.

SUMER active region sequences:

Initial pointing:	Sun centre
Step size:	no rastering
Pixels per spectral line:	120×25
Compression:	Quasilog (compression type 5)
Solar rotation compensation:	yes
Co-operation requirements:	copointing with CDS

Sequence 1:

Spectral lines:	Ar III 508.61 Å (refpix 295), N III 991.58 Å, Unknown 988.6 Å
Slit:	0.3×120 arc sec^2 (slit 6)
Integration time:	30 sec
Duration of sequence:	2 hours

Sequence 2:

Spectral lines:	He I 584.33 Å(refpix 38), O I 1152.15 Å N V 572.34 Å
Slit:	0.3×120 arc sec^2 (slit 6)
Integration time:	15 sec
Duration of sequence:	2 hours

Sequence 3:

Spectral lines:	Cl I 1351.66 Å(refpix 720), C I 1354.3 Å, Fe II 1369.17 Å, Fe II 1361.37 Å
Slit:	0.3×120 arc sec^2 (slit 6)
Integration time:	30 sec
Duration of sequence:	2 hours

Sequence 4:

Spectral lines:	Si IV 1393.76 Å(refpix 238)
Slit:	0.3×120 arc sec^2 (slit 6)
Integration time:	30 sec
Duration of sequence:	2 hours

CDS quiet sun sequence:

Initial pointing:	Sun centre
Slit:	90×120 arc sec^2
Spectral lines:	Mg IX 368.06 Å, He I 584.33 Å, O V 629.73 Å
Step size:	no rastering
Dwell time:	15s
Compression:	16 bits → 12 bits
Solar rotation compensation:	yes
Duration of movie:	15 min.
Repetition:	40 times
Total time of sequence:	10 hours
Cooperation requirements:	Copointing with SUMER (SUMER slit should remain within field of view of MOVIE over the whole duration).

CDS active region sequence:

Initial pointing:	Active region to be determined
Slit:	2×240 arc sec^2
Spectral lines:	Fe XVI 360.76 Å, Fe XII 364.47 Å, Si XII 520.67 Å, Al XI 550.00 Å, Al XI 567.80 Å, He I 584.33 Å, Mg X 624.94 Å, O V 629.75 Å
Step size:	no rastering
Dwell time:	15s
Compression:	16 bits → 12 bits
Solar rotation compensation:	yes
Duration of observation:	2 hours
Repetition:	5 times (at different spatial positions)
Total time of sequence:	10 hours
Cooperation requirements:	Copointing with SUMER (SUMER slit should remain within field of view of MOVIE over the whole duration) if the active region crosses the meridian.

MDI sequence:

High resolution magnetograms at a rate of 1 per minute, if possible over the whole period of time, or whenever real time data transfer is possible.

EIT sequence:

Full resolution images of all 4 spectral lines. If possible, high cadence of observations over at least a part of the period.