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

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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 $4 \times 10^2$ 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

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 necessary 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:

<table>
<thead>
<tr>
<th>Spectral lines:</th>
<th>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</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slit:</td>
<td>1.0×120 arc sec$^2$ (slit 3)</td>
</tr>
<tr>
<td>Integration time:</td>
<td>15 sec</td>
</tr>
<tr>
<td>Duration of sequence:</td>
<td>5 hours</td>
</tr>
</tbody>
</table>

Sequence 2:
Spectral lines: O V 629.73 Å, C I 1267.60 Å (refpix 733)
Slit: 1.0×120 arc sec² (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 sec² (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 sec² (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 sec² (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 sec² (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:** 0.3x120 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:** 0.3x120 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:** 0.3x120 arc sec$^2$ (slit 6)
- **Integration time:** 30 sec
- **Duration of sequence:** 2 hours

### CDS quiet sun sequence:
- **Initial pointing:** Sun centre
- **Slit:** 90x120 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:
<table>
<thead>
<tr>
<th><strong>Initial pointing:</strong></th>
<th>Active region to be determined</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Slit:</strong></td>
<td>2x240 arc sec$^2$</td>
</tr>
<tr>
<td><strong>Spectral lines:</strong></td>
<td>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</td>
</tr>
<tr>
<td><strong>Step size:</strong></td>
<td>no rastering</td>
</tr>
<tr>
<td><strong>Dwell time:</strong></td>
<td>15s</td>
</tr>
<tr>
<td><strong>Compression:</strong></td>
<td>16 bits → 12 bits</td>
</tr>
<tr>
<td><strong>Solar rotation compensation:</strong></td>
<td>yes</td>
</tr>
<tr>
<td><strong>Duration of observation:</strong></td>
<td>2 hours</td>
</tr>
<tr>
<td><strong>Repetition:</strong></td>
<td>5 times (at different spatial positions)</td>
</tr>
<tr>
<td><strong>Total time of sequence:</strong></td>
<td>10 hours</td>
</tr>
<tr>
<td><strong>Cooperation requirements:</strong></td>
<td>Copointing with SUMER (SUMER slit should remain within field of view of MOVIE over the whole duration) if the active region crosses the meridian.</td>
</tr>
</tbody>
</table>

**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.