Title: Prediction of the EUV Helium line intensities in the solar atmosphere

Short title: Prediction of Helium intensities

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Participating instruments and observatories
SoHO/SUMER
SoHO/CDS
Hinode/EIS

Scientific justification
The study of helium line formation in the EUV solar spectrum can provide understanding of the physics of the lower transition region. Helium is one of the few elements that exhibits strong emission lines formed in the upper chromosphere/lower transition region and it is the second most abundant element in the Sun. However, analysing helium lines in the solar atmosphere is a particular challenging task, because of their optical thickness and the unusual behaviour of their intensities (Jordan, 1975; Pietarila & Judge, 2004). Such a study requires spatially and spectrally resolved observations in the EUV range as well as sophisticated atomic modelling. The work focuses on to what extent differential emission measure (DEM) distributions can reproduce the observed fluxes of the He I and He II lines, as observed by the Hinode/EIS and SoHO/CDS. It will also examine what is the mechanism that enhances the helium line intensities compared to other transition region lines (Shine et al., 1975; Fontenla et al., 1993; Fredvik & Maltby, 1998; Andretta et al., 2000; Smith & Jordan, 2002; Judge & Pietarila, 2004; Jordan et al., 2005; Mauas et al., 2005; Andretta et al., 2008; Judge, 2008).

Hinode EIS observes a strong resonance line of He II at 256 Å. This will be combined with SoHO/CDS observations of all resonance lines of He I and the line of He II at 303.8 Å in 2nd order. The peculiar behaviour of He lines in the solar upper atmosphere will be analysed using DEM. The DEM approach requires to include some lines at the lower temperatures at which He lines are formed ($\log(T_e/K)$~4.5 for He I and ~4.7 for He II). To achieve this, we request simultaneous observations using the three instruments SoHO/SUMER, SoHO/CDS and Hinode/EIS both for active region and quiet Sun targets.

Date and time information
The JOP is requested to be carried during a joint Hinode/SUMER/CDS campaign in April 15-30, 2009.

Targeting requirements

The preferred target will be an active region, but quiet sun will be observed if no active region available. Please note the active region observation has the highest priority.

Detailed observing sequences per instruments

SoHO/SUMER (study already written by Curdt Werner):

Targets:

- Active regions on disk (preferably within ±5 arcmin from disk centre, but other disk locations will also be acceptable).
- Quiet Sun near disk centre (if no active region available)

Slits:

- 1×120 arcsec^2

Raster area:

- 60×120 arcsec^2

Emission lines

- RASTER 1 – Left of Ly-α
  - Band 1 (751 Å – 792 Å)
    O IV 787.72 Å
    O IV 790.19 Å
    O V 761.99 Å
    Ne VIII 770.49 Å
    Ne VIII 780.32 Å
  - Band 5 (940 Å – 980 Å)
    He II 958.70 Å
  - Band 6 (1160 Å – 1200 Å)
    He I 584.34 Å
    C III 1174.88 Å
    C III 1175.24 Å
    C III 1175.59 Å
    C III 1175.74 Å
    C III 1175.98 Å
    C III 1176.37 Å

- RASTER 2 – Right of Ly-α
  - Band 2 (1252 Å – 1292 Å)
    O V 629.77 Å – in the 2nd order
    Si II 1264.74 Å
    Si II 1265.00 Å
  - Band 3 (1300 Å – 1340 Å)
    Si II 1304.37 Å
    Si II 1309.28 Å
    C II 1334.52 Å

C II 1335.71 Å

Observing sequence:
Two observing dates, on April 17, 12:00-16:00 UT and April 28, 20:00 – 24:00 UT
Active region (196 minutes) or Quiet Sun backup (196 minutes):
Repeat the sequence "RASTER1 – RASTER 2" at least 3 times (196 minutes).
Use solar tracking. If no active region, observe quiet sun as a backup target.
If 10 hours available during the campaign, repeat this observation on another active region or a different part of the same region (can be run on a different day).
NOTE: both rasters are needed, but in the event of unforeseen problems, RASTER 2 is more important because it contains vital lines.

SoHO/CDS:
When running this JOP, CDS will use the observing sequence ATRIC12 (full spectra) to be updated after discussions with A. Fludra.

Hinode/EIS (EIS studies submitted for testing):
Targets:

- Active regions on disk (preferably within ±5 arcmin from disk centre, but other disk locations will also be acceptable).
- Quiet Sun near disk center.

Slits:

- 1×256 arc sec^2
- 2×256 arc sec^2

Raster area:

- 60×256 arc sec^2

Emission lines:

- Helium line: 256.3 Å.
- Lines for co-alignment between instruments: O V 184.1 Å, O V 192.9 Å, Si VII 275.3 Å, Si VII 275.7 Å, O IV 279.6 Å, O IV 279.9 Å.
- Lines at high temperature (for D.E.M. analysis): Fe X 184.5 Å, Fe XII 186.9 Å, Fe VIII 186.6 Å, Fe XI 192.8 Å, Fe XII 193.5 Å, Fe XVI 262.9 Å.

The following rasters have been submitted for validation:

ral_he_int_1slit
Data rate: 12 kbits/s
Data volume: 32 Mbits
Cadence: 44 minutes, 20 seconds

ral_he_int_2slit
Data rate: 23 kbits/s
Data volume: 16 Mbits
Cadence: 11 minutes, 51 seconds

Duration of observations:
Two observing dates, on April 17, 12:00-16:00 UT and April 28, 20:00 – 24:00 UT
On each date, the preferred target will be an active region, but quiet sun will be observed if no active region available.
Active region (4 hours):
Raster: ral_he_int_2slit, repeat at least 10 times (2 hours), point to bright transition region emission or strong magnetic field concentrations (but preferably not sunspot) (apply solar rotation tracking)
Raster: ral_he_int_1slit, repeat 3 times (2 hours). Point to the same area where the previous ral_he_int_2slit raster finished, continue tracking solar rotation.