JOP177 ENERGY INPUT IN PROMINENCES.

WHO ?

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WHEN ?

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WHY ?

The target of this proposal is the study of fluctuation of energy-input in prominences, by the measure of temperature variation. A prominence is a continually renewed structure, never the same. During its lifetime a prominence can undergo an important increase in energy input, which induces a "sudden disappearance" and consequently the obliteration of the prominence from Hα image, the usual wavelength for prominence observations. SKY LAB had shown such variation of visibility produced by changes in ionisation degree of plasma and thereby the complete ionisation of hydrogen. The effect of heating is an apparent disappearance of prominence in H I lines and its appearance in lines of Transition Zone or soft X-ray images, depending how much the energy-input is. This process was called "thermal disappearance", with respect to "dynamic disappearance" which is the ejection of plasma into the corona (Mouradian et al., Proc. of the Japan-France Seminar on Solar Physics 1981, p. 195; Tandberg-Hanssen, The Nature of Solar Prominences, 1995, p.240). So, we are led to distinguish two sorts of prominence disappearance: thermal and dynamic, with different consequences on CME formation (Mouradian et al, Solar Phys. 1995, **158**, 269). Note that after a certain time the heating being stopped, cooling restores Hα prominence.

In an earlier paper, we studied the possibility for a thermal disappearance of prominence produced by resonant absorption of Alfvén waves and concluded to the efficiency of this process (Ofman & Mouradian, A&A 1996, **308**, 631).

The SOHO/SUMER spectrometer allowed us to start a campaign in order to study the thermal variability. An arch-shaped prominence was observed on March 31, 1996 and we determined the distribution of temperature variation over the prominence surface (Ofman et al, Solar Phys. 1998, **183**, 97). The method used for the measure of temperature was the intensity ratio at two wavelengths in Lyman continuum (I_{908} / I_{877}), quantity which is only temperature dependent. In order to calculate this dependence, we used GHV model for H I, which works in the range 4300 to 15000K (Heinzel, Vial & Gouttebroze, A&A Suppl., 1993, **99**, 513). We effectively observed the heating process, as mentioned above, but the time-constant of observation was too long to detect the *heating characteristics* and *topology of energy flow*. These observations showed some topological effects of heating never pointed out before, which have to be studied and confirmed for other prominences. For these reasons we intend to start a new and more complete campaign of observation.

The SOHO/EIT imaging telescope will be associated to the above-mentioned heating program, because it improves and completes the temperature range covered by SUMER and can show the heating propagation in the whole body of the prominence. Working simultaneously with both instruments (SUMER and EIT) we can watch the unfolding of heating through the He II ionisation and Fe IX + X excitation. The observation of He II emission during a disappearance and appearance of prominence may contribute to the understanding of He excitation.

During the 2004 campaign we would like to use again the Ly cont. sequence and we also intend to observe the temperature variation using Ly β + O VI, as well as by Ly decrement, which were considered but not performed in the preceding period. We propose to study the profiles of emission lines of Ly β and O VI. In case of disappearance of prominence in H I lines, O VI becomes emissive with the same shape. The C II lines will be used for wavelength reference. The third way for temperature measure is given by Lyman decrement using the lines Ly 6 to Ly 20 of H I. We also intend to study the role of multiple scattering for the H I line formation, in the different physical conditions present in prominences.

ALTERNATIVE PROGRAM

In case of a lack of prominences, Ly β + O VI sequence can be applied for spicule observations as well. Here again the target will be the heating of spicules related to their upward motion.

HOW ?

In order to obtain a good approach of the prominence-heating problem it seems necessary to observe about 4-5 different prominences, each of them being watched for about 6 hours.

The selection of targets will be done the day before. The west limb prominences will be preferred.

For a good positioning of prominence structures on the slit, before starting observation, the slit must be first adjusted crossing the solar limb. A spectral range with low sensibility of the receiver should be used to take a few spectra. Then the slit will be shifted along itself toward the prominence to overlap it and a few spectra in He II 942 Å (935-945 Å) will be taken, necessary for comparison with simultaneous EIT images. The observation program can only start after having set the slit.

SUMER and EIT observations have to be simultaneous and at daytime in Europe, in order to be supply the SOHO observations with ground base instruments.

Lyman continuum

SUMER:

The 4 observing windows: 877 ± 3; 890 ± 3; 900 ± 3; 908 ± 3 Å, (with binning)
Slit: 1×300 arcsec.
Exposure time: 30 sec
Frequency: 2 / min
Run time: 6 hours of continue observation

EIT:

Small field images (300" × 300") in He II (304 Å) and Fe IX +XI (171 Å),
Frequency: every 15 min
Run time: 6 hours of continue observation

Ly β + O VI

SUMER:

Spectral range: 1024 – 1040 Å; (annexe 1)
Slit: 1×300 arcsec.
Exposure time: 45 sec
Frequency: every 45 sec.
Run time: 6 hours of continue observation

EIT:

Small field images (300" × 300") in He II (304 Å) and Fe IX +XI (171 Å);
Frequency: every 15 min
Run time: 6 hours of continue observation

Ly decrement.
SUMER:

Spectral range: 910 – 939 Å; (annexe 2)
Slit: 1×300 arcsec.
Exposure time: 30 sec
Frequency: 2 / min
Run time: 6 hours of continue observation

EIT:

Small field images ($300'' \times 300''$) in He II (304 Å) and Fe IX +XI (171 Å),
Frequency: every 15 min
Run time: 6 hours of continue observation

Ly β + O VI – Spicule (this program will be repeated for 2 - 3 days)
SUMER:

Slit position parallel to limb, at altitude 6" (4400 km) and 11" (8000 km) above limb. A similar procedure for slit positioning will be used.
Slit: 0.3×120 arcsec.
Exposure time: 20 sec
Frequency: 3 / min
Run time: 6 hours of continue observation

EIT:

Small field images ($300'' \times 300''$) in He II (304 Å) and Fe IX +XI (171 Å),
Frequency: every 15 min
Run time: 6 hours of continue observation

Ground Based Support:
Meudon Observatory in K3 prom. specroheliogram.
Pic du Midi Observatory Hα coronograph filtrogram.
Kanzelhöhe Observatory, Hα prominence filtrogram.
Frequency of support image: every 15 min.(hour + 0; + 15; + 30; + 45 min.)

ANNEXE 1

Spectral range for Ly β + O VI — Prominences and Spicules

λ Å	Spectral element
1025.30	H II
1025.72	Ly β
1031.92	O VI
1036.34	C II
1037.02	C II
1037.61	O VI

ANNEXE 2

Spectral range for Lyman decrement — Prominences

λ Å	Spectral element
910 – 912.5	H I Ly cont
913.6	H I Ly 20
913.9	H I Ly 19
914.2	H I Ly 18
914.5	H I Ly 17
914.8	H I Ly 16
915.4	H I Ly 15
915.8	H I Ly 14
916.4	H I Ly 13
916.7	S VIII
917.2	H I Ly 12
918.2	H I Ly 11
919.4	H I Ly 10
920.9	H I Ly 9
923.2	H I Ly 8
926.2	H I Ly 7
930.74	H I Ly 6
933.10	S VI + He II
937.80	H I Ly 5