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INFLUENCE OF TRANSITION REGION BLINKER ON THE SURROUNDING CHROMOSPHERIC AND CORONAL PLASMA

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Conference paper

Abstract. Results of spectral analysis of a blinker observed in the transition region O VI 1037.63 Å line and in the chromospheric Ly β 1025.72 Å line which were acquired using the SUMER spectrometer are presented. Chromospheric and coronal plasma in the vicinity of the blinker are investigated using also TRACE Ly α, UV continuum and Fe IX channels. It was found that initial release of energy was localized in the transition region and plasma has been spreading from transition region as a bi-directional jet. Energy reached chromosphere ∼60 seconds after primary emission in the O VI line. There were detected enhanced emissions for about 25-38% in the chromospheric Ly α and UV continuum. Spatial extent of the blinker response is 6" along the slit in the Ly α filtergram what is ∼3" less than extent of the blinker in the O VI line. Maximum extent of the blinker response is 7.5" in Ly α filtergram. Although, both Ly α and UV continuum reflect physical conditions in chromosphere, their patterns are completely different: pattern of the blinker response is compact in the Ly α and UV continuum shows non-compact structure below the transition region blinker. Coronal plasma was not influenced by the blinker although plasma moving toward observer was detected in the final phase of evolution of the blinker.

Key words: chromosphere - transition region - blinker - corona

1. Introduction

Harrison (1997) first introduced term 'blinker' for a small-scale phenomenon observed in the transition region of the quiet Sun in EUV lines with the intensity enhancement factor of 2-3, duration ranging from 1 to 30 min and with the typical area of $3.6\times10^7\,\mathrm{km}^2$. The blinkers were found in the quiet Sun (Bewsher *et al.*, 2002) and in active regions (Parnell *et al.*, 2002) as well. Similar properties of the blinkers were derived in both locations and values were close to those estimated by Harrison. The blinkers are found to occur preferentially over network boundaries where one polarity dominates (Bewsher *et al.*, 2002). Dynamic nature of the blinkers was not revealed until Tomasz *et al.* (2003) observed small velocities of $15\,\mathrm{km\,s^{-1}}$ of both signs in the O VI line and Bewsher *et al.* (2003) derived velocities for the blinker ranging from 10 to $30\,\mathrm{km\,s^{-1}}$ in the quiet Sun and from 10 to $40\,\mathrm{km\,s^{-1}}$ in active region. As there exist plasma flows moving toward solar surface and toward observer in the blinkers a question arises: do these flows reach and affect lower and upper layers, i. e. chromosphere and corona? Aim of this study is to address this question in case of the particular transition region blinker already investigated in works of Tomasz *et al.* (2003, 2004).

2. Data and Data Reduction

UV spectral data have been selected from our observations of the quiet Sun performed on May, 5th 1999 from 8:25 UT to 13:15 UT using the SUMER/SOHO instrument (Wilhelm *et al.*, 1995). During almost 6 hours of observations 1200 spectra were taken and exposure time of the spectral image was 14.25 seconds. Details of the observations are described in Tomasz *et al.* (2003).

Two UV spectral lines were selected in order to examine chromosphere and transition region: Ly β 1025.72 Å and O VI 1037.63 Å (3×10^5 K). The standard reduction of the data was performed using the SUMER reduction procedures. Individual profiles of the O VI line were fitted in order to get spectral characteristics - central intensity, Gaussian width and Doppler shift (for details see Tomasz *et al.*, 2003). The most rapid changes in the last spectral characteristics point at highly dynamical process - a blinker. It was found near the supergranular lane almost in the middle of the spectrograph slit in the interval from 62" to 71" (for detail see Figure 1 and

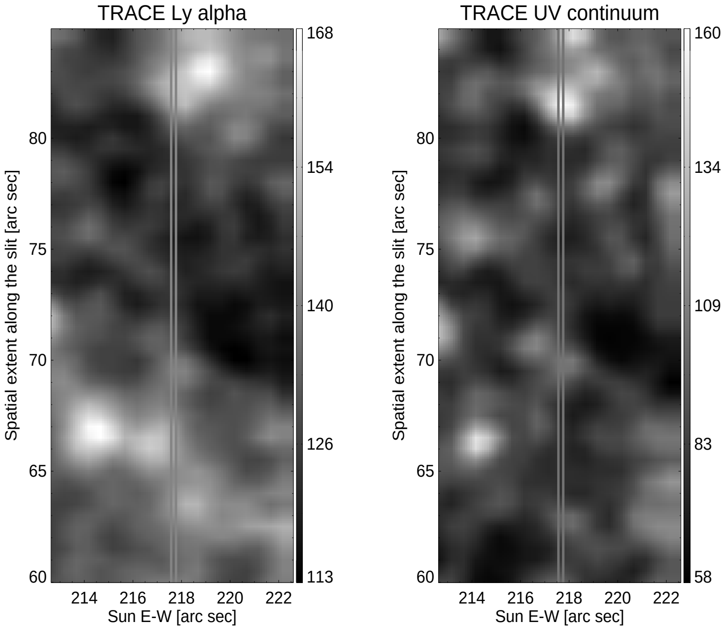

Figure 1: Vicinity of the blinker in two TRACE channels. Position of the SUMER slit is over-plotted with two grey vertical lines. The grey-scale bar on the right shows range of the total emission of the Ly α line and the UV continuum (instrumental units). The blinker is centred at the position 66" in N–S direction. Both filtergrams were taken at 9:29 UT.

Figure 2). The blinker was observed from about 9:23 to 9:31 UT. Hereafter we compare the central intensities, the Doppler shifts and the Gaussian widths of the transition region line to the total emission of the Ly β line to see similarities or differences of the blinker pronounced in the above mentioned layers of the solar atmosphere. The blinker was identified via changes of all spectral characteristics of the transition region line. TRACE filtergrams (Handy *et al.*, 1999) were also selected to cover the blinker occurrence between 9:15 UT and 9:43 UT. Two chromospheric channels of UV continuum 1600 Å (4–10$\times10^3$ K) and Ly α 1216 Å line (10–30$\times10^3$ K) and one coronal Fe IX 173 Å channel (1.6–20$\times10^5$ K) were chosen. For the particular channels different exposure times were used: 46 s for the Fe IX, 4.1 s for the Ly α and 2 s for the UV continuum channels, respectively. Raw data were reduced for effects of dark current, flat-field, cosmic rays, solar rotation and residual motions. Co-alignment of the SUMER and TRACE data was done applying cross-correlations of the Ly β total emission and slices selected from the Ly α filtergrams (Tomasz *et al.*, 2004). Thus, it was possible to localize SUMER slit in TRACE filtergrams (Figure 1).

3. Results

Panels in Figure 1 show region of the chromosphere where the blinker response could be detected, if the blinker in the transition region released enough energy to reach the chromosphere. The blinker was located between the slit position of 62" and 71". There is a large bright patch of the increased emission in the Ly α channel centred off-slit at position 217", 66.5" (Figure 1, left panel). Size of the blinker underlying area in the Ly α channel along the slit is ∼6", but across the slit its size is larger for about 1.5". However, in the UV continuum channel three bright patches are visible in the area of the blinker response in the Ly α filtergram (Figure 1). One patch is identical with the brightest part of the Ly α emission (217", 66.5"). Two others are situated off-slit at 214.5", 66.5" and 219.5", 65", respectively. In both chromospheric channels lifetime of the blinker response is similar ∼5.3 min. Emission enhancement factor of the blinker response is 1.38 in the Lyα line and 1.25 in UV continuum, respectively.

Analysing the total emission of the Ly β line (Figure 2, background) we figured out duration and size of the blinker in the chromosphere to be 6 minutes and 7", respectively. The blinker has shown different duration and spatial extent in the particular spectral characteristics of the transition region line (Tomasz *et al.*, 2003). Comparisons between the total emission of the Ly β line and the intensity, the Doppler velocity and the Gaussian width of the O VI line are shown in the Figure 2. Comparison of the total emission of the Ly β line with the intensities of the O VI line (Figure 2, upper left panel) showed that:

- the blinker appeared in chromosphere of about 90 s later than in the transition region,
- size of the blinker in chromosphere (7") is smaller then its size in the transition region (10"),
- maximum of the total emission of the Ly β line is spatially shifted for about -2" comparing to the maximum of intensity of O VI line,

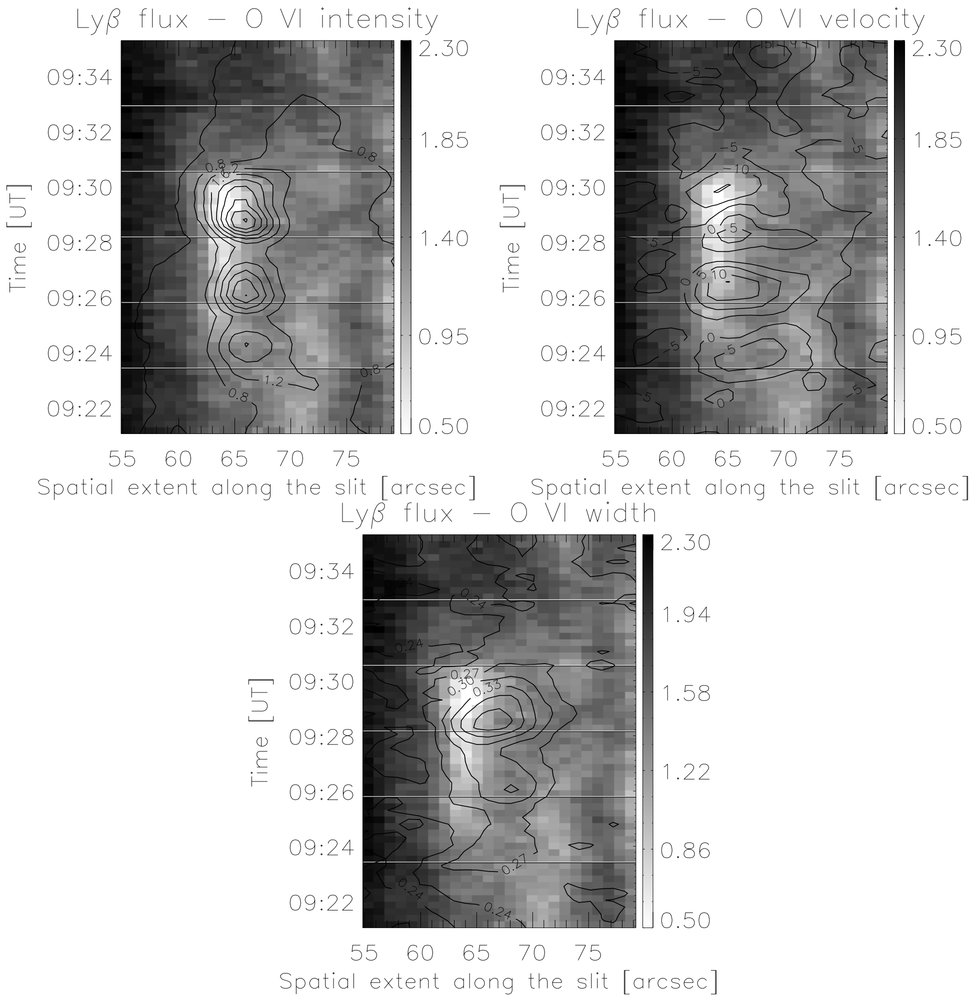

Figure 2: Temporal and spatial behaviour of the intensity (W sr^{-1} m^{-2} Å^{-1}), the Doppler velocity (km s^{-1}) and the Gaussian width (Å) of the O VI line compared to the total emission of the Ly β line during the blinker. Shaded background is the total emission of the Ly β line. Its scale is given in the grey-scale bar on the right and units are expressed in W sr^{-1} m^{-2}. Particular levels and their values for each spectral characteristic of the O VI line are over-plotted with contours. Bright horizontal lines mark moments of the slit jumps which were performed in order to compensate for solar rotation (Tomasz *et al.*, 2003).

– appearance of maximum of the total emission of the Ly β line is shifted of about 55 s in time comparing to appearance of maximum of intensity of the O VI line.

Comparison of the total emission of the Ly β line with the Doppler shifts of the O VI line (Figure 2, upper right panel) showed that:

– negative velocities (plasma moving toward observer) in the O VI line were detected only in the final phase of evolution of the blinker and they were localized above the region where maximum of the total emission of the Ly β line appeared,
– positive velocities lasted for former 7 min and their spatial extent along the slit is larger than spatial extent of the negative velocities and larger than spatial extent of the total emission of the Ly β line as well.

From comparison between the total emission of the Ly β line and the Gaussian width of the O VI line (Figure 2, bottom panel) it is evident, that:

– changes of the Gaussian width of the O VI line precede changes in the total emission of the Ly β line for about 70 s,
– total emission of the Ly β line is spatially shifted for about -3" relatively to the Gaussian width of the O VI line.

Contrary, no emission from the blinker was detected in the coronal Fe IX channel. Even, no emission was present before and after the blinker occurrence in the transition region. Therefore, no figure of this part of atmosphere is presented.

4. Conclusion and Discussion

There are two reasons why transition region ($\sim 10^5$ K) was found to be a primary site of the blinker energy release. Firstly, there is a time lag between increase of the intensity of the O VI line and increase of the Ly β line emission. Secondly, positive velocities of the O VI line were detected, it means that plasma has moved toward chromosphere. During the last third of the blinker lifetime upward motions toward corona were presented. Despite of these motions no emission was detected in corona and hence plasma with temperature around 1MK was not influenced by the blinker.

We note that single Gaussian fitting of the O VI line reveals only dominant Doppler velocity and hence this method is not appropriate tool for investigation of complex plasma motions. Enhancement of the O VI Gaussian width was due to either higher turbulent motions or the line profiles become multi Gaussian.

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UTJECAJ BLISTAJA PRIJELAZNOG SLOJA NA OKOLNU PLAZMU KROMOSFERE I KORONE

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Izlaganje sa znanstvenog skupa

Sažetak. Prikazuju se rezultati spektralne analize jednog blistaja opažanog u liniji prijelaznog sloja O VI na 1037.63 Å i u kromosferskoj liniji Ly β na 1025.72 Å pomoću SUMER spektrometra. Plazma kromosfere i korone u okolini blistaja se istražuje pomoću mjerenja TRACE u Ly α, UV kontinuumu i Fe IX spektralnim prozorima. Ustanovljeno je da je početno oslobađanje energije bilo lokalizirano u prijelaznom sloju te da se je plazma širila iz tog sloja u obliku dvosmjernog mlaza. Energija je dospjela do kromosfere oko 60 sekundi nakon prvotne emisije u liniji O VI. Detektirana je za oko 25-38% pojačana emisija u kromosferskoj Ly α liniji i UV kontinuumu. Dimenzije odaziva blistaja iznose 6" uzduž pukotine u Ly α filtergramu, što je za oko 3" manje nego rasprostiranje blistaja u liniji O VI. Maksimalno rasprostiranje odaziva blistaja u Ly α filtergramu iznosi 7.5". Iako i Ly α i UV kontinuum odražavaju fizikalne uvjete u kromosferi, njihovi uzorci su sasvim različiti: uzorak odaziva blistaja u Ly α liniji je kompaktan, dok UV kontinuum pokazuje nekompaktnu strukturu ispod blistaja prijelaznog sloja. Blistaj nije imao uticaja na plazmu korone, iako je u zadnjim fazama razvoja blistaja detektirana plazma koja se giba u smjeru opažača.

Ključne riječi: kromosfera - prijelazni sloj - blistaj - korona