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TRANSITION REGION BLINKER - SPATIAL AND TEMPORAL BEHAVIOUR

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Abstract. The most prominent transient event is presented from an extensive search for the transition region internetwork activity in the quiet Sun atmosphere. The basic physical and geometrical parameters of this event are derived from the O VI 1037.61 Å emission spectral line. The spatial extent of 11 000 km, duration for 9 minutes, intensity enhancements factor of 7 and large Doppler velocities of both signs were estimated for the event. According to these values this event was identified as a transition region blinker.

1. Introduction

One of the greatest enigmas of the solar physics is the problem of the coronal heating. This problem is still considered to be not sufficiently solved. Many processes which could be responsible for the coronal heating were proposed (e.g. Narain and Ulmschneider, 1990; Roberts, 2000). It is possible to observe various types of active events in the transition region, for example blinkers and explosive events. Relation of the events to the energy input to the corona is still unclear. The main difference between these two phenomena is that the spectral

	Blinkers	Explosive Events
Intensity	strong brightening	little brightening
Life time	$6 - 40$ min	$1 - 2$ min
Birth rate	$1.2\,\mathrm{s}^{-1}$	$600\,\mathrm{s}^{-1}$
Doppler shift	small (≤ 20 km/s)	large ($100 - 150$ km/s)
Size	6000 x 6000 km	1500 x 1500 km
Locations	network	edges of network brightenings

Table 1: Typical parameters of the blinkers and the explosive events observed in the transition region (Fleck, 1999).

line profile is significantly broadened in the case of explosive event, unlike the blinker, which manifests strong increase of the line intensity. Typical parameters of these two events are given in Tab. 1. In this paper we investigate the small-scale and rapid changes of an active phenomenon found in the internetwork of transition region.

2. Observations and data reduction

Three spectral lines (Tab. 2) originating in the lower and upper layers of the transition region were selected from the whole set of 6 spectral lines. Data, analyzed in this paper, has been acquired on May 5th, 1999 (08:25 - 13:15 UT) with the SUMER instrument (Wilhelm et al., 1995) on-board SOHO. A time series of 1200 images covering the spectral range from 1035.81 Å to 1038.87 Å was taken with an exposure time of 14.25 s. Coordinates of the center of slit at the beginning of observation were -65.25″ (N-S), 223.3″–267.9″ (E-W) and the slit size was 0.3″x120″. The on-board solar-

Spectral line	Wavelength [Å]	Layer	Temperature [K]
C II	1036.34	lower TR	3×10^4
C II	1037.02	lower TR	3×10^4
O VI	1037.61	upper TR	3×10^5

Table 2: Basic parameters of the selected spectral lines including the regions and temperatures of the spectral lines formation (Kučera et al., 1999).

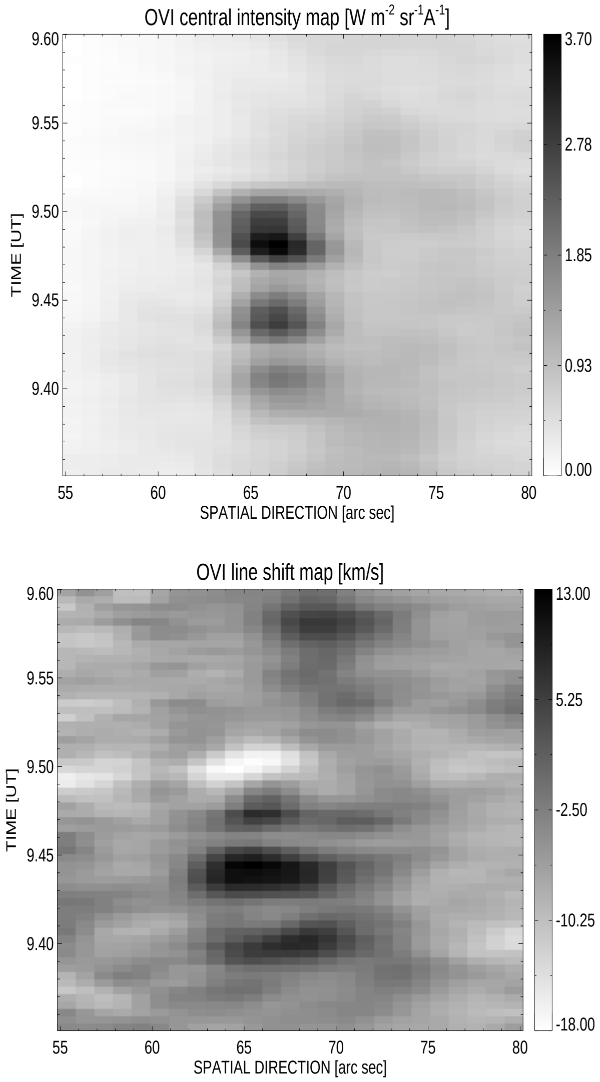

Figure 1: The space-time 2D maps of the intensities and the Doppler velocities of the O VI line. Horizontal axis: the spatial direction along the slit, vertical axis: time.

rotation tracker was disabled and a special so-called half-step solar rotation compensation scheme was applied.

The standard reduction of the data was performed using the SUMER reduction procedures and our own programs. The final spectral profiles were used to determine the spectral characteristics. Individual profiles were fitted simultaneously with single Gaussian and a constant background for continuum.

Three spectral characteristics: I_0 - central intensity of the line, W - the Gaussian width, and V_d - the Doppler shift, were derived for each spectral line. The V_d zero level was derived as an average value of the quiet Sun internetwork velocities. Additionally the continuum intensity I_c and a measure of the fitting accuracy χ^2 were calculated.

The most pronounced transient event – according to the enhancement of I_0 and changes of V_d – was selected for the detailed study. The 2D maps of the spectral characteristics of one of observed line (O VI) are shown in Fig.1. Location of the event is at the spatial position 63"-73" and in the temporal span from 9.37 to 9.52 UT. A triple enhancement of all spectral characteristics is seen during the event. The first two enhancements are similar in their spatial extent and the third one is much larger and it lasted longer than smaller enhancements. Duration of the whole transient triple event was 9 minutes and its spatial extent was $\sim$11 000 km. The rapid change of the sign of the Doppler shift V_d is remarkable after the third slit shift. Ranges of the measured values of the spectral characteristics of all spectral lines are given in Tab. 3.

A detailed analysis of the motion of the SUMER slit has shown that the triple change of the spectral parameters was caused by displacement of the spectrograph slit (Fig.2). All enhancements of the I_0 and V_d follow the slit shifts except the third enhancement of the V_d which was before the moment of the slit shift (Fig.2, panels 3 and 4). Slit moved eastward and its distance from disk center increased (Fig. 2, upper panel). This slit movement was needed for the compensation of the solar rotation in order to observe the identical target on the solar disk. Slit displaced three times – at 9.38 UT, 9.43 and 9.47 UT. The relative distance between the actual slit position and the target is shown in Fig. 2 (panel 2). The changes of the I_0 and V_d of the O VI spectral line (two bottom panels) are seen around the moments of the slit displaced (marked with the dashed vertical lines).

Very high χ^2 values obtained from the profiles fitted by simple Gaussian

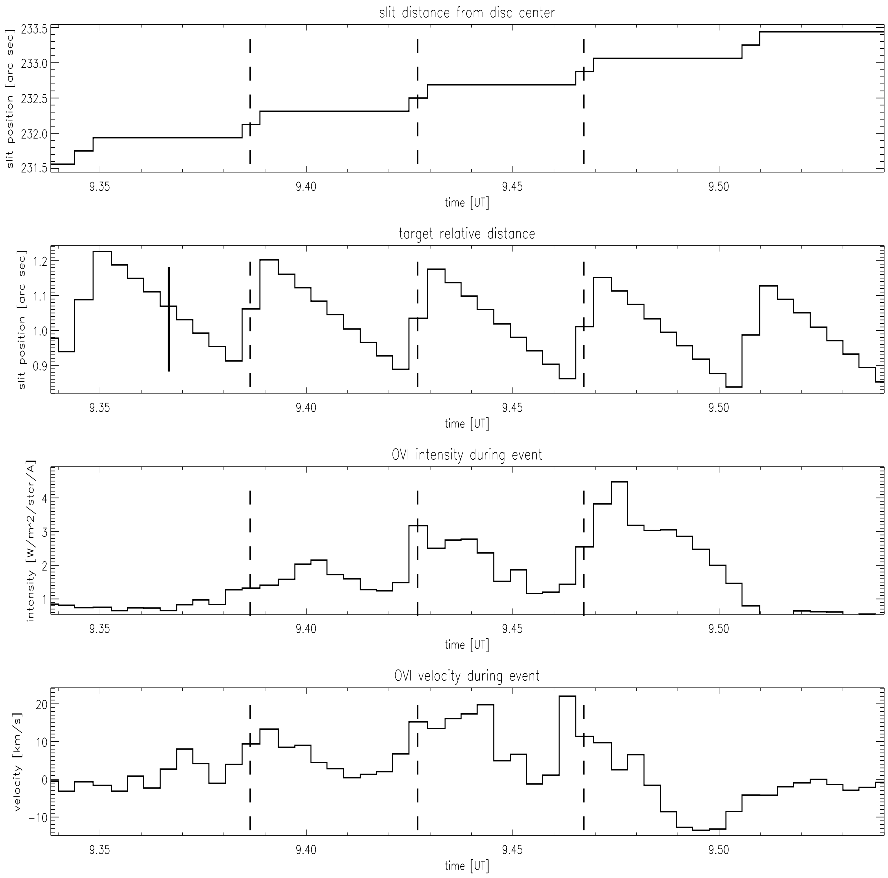

Figure 2: Slit characteristics and changes of the O VI line spectral characteristics during the observed transient event. The changes of the O VI spectral characteristics (two bottom panels) are seen around these moments of the slit displacement (marked by the dashed vertical lines). Description of the vertical axes: The first panel: the slit position on the solar disk (E-W). The second panel: the distance between the actual slit position and the target. The third panel: intensity of the O VI line. The fourth panel: velocity of the O VI line. Vertical solid line (panel 2) shows the real width of the slit (0.38").

Spectral line	Intensity $[\mathrm{Wm^{-2}sr^{-1}Å^{-1}}]$	Velocity $[\mathrm{km\ s^{-1}}]$	Gaussian width [Å]
C II 1036.34 Å	0.06 – 0.80 (0.11)	-14.81 – +3.50	0.15 – 0.25 (0.08)
C II 1037.61 Å	0.08 – 0.84 (0.13)	-14.00 – +2.00	0.15 – 0.27 (0.08)
O VI 1037.61 Å	0.14 – 3.65 (0.22)	-15.80 – +14.60	0.21 – 0.41 (0.10)

Table 3: Observed values of the spectral characteristics of the spectral lines in the transient event. There are given average values of the spectral characteristics of the quiet Sun internetwork in the brackets.

profiles signalized that there were more complicated spectral profiles and multi-Gaussian fitting of the spectral lines by several Gaussian profiles will be necessary to apply in future. This is in agreement with the positive and the negative values of the Doppler shifts found in the third enhancement of the observed transient event what is typical feature for the explosive events (Innes et al., 1998). This property of the explosive events is in good agreement with the theoretical effort to explain explosive events with the simultaneous bi-directional jets of plasma caused by magnetic reconnection (Chae, 1998). Nevertheless, the amplitudes of the Doppler velocities in the event are of an order lower than in the typical explosive events.

3. Conclusion

A transient event in the internetwork of the transition region was observed. Considering the estimated parameters of this event we have identified it as a blinker. The diameter of the blinker was ~11 000 km, duration of the whole effect was 9 minutes and the intensity of the O VI line reached 700% of the value of the quiet Sun. The triple occurence indicates that the blinker seems to happen on a sub-arcsec scale and is highly variable. The blinker shows several small-scale differences of the spectral characteristics during the event. The detection of the effect of a moving slit will allow us to investigate not only temporal but also spatial changes of the characteristics of the blinker in future.

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