Observations of Explosive Events in the Solar Atmosphere

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Abstract:
Two ultraviolet explosive events are reported here; one which lasted over 2 mins and was detected in a region within the northern polar coronal hole and a second event which lasted over 4 mins and was detected within an active region. The coronal hole event first showed a mass upflow, followed by blue and red-shifted plasma, then finally a red-shifted plasma. Velocities reached \(\sim 120\) km s\(^{-1}\). The active region event was more energetic, showing a second injection after about 2 mins. The maximum velocity reached 300 km s\(^{-1}\). Towards the end of each of these events, the location of the mass upflow/downflow had shifted by 3–4 arcsec compared to the initial location.

1. Introduction

With the launch of SOHO new opportunities have become available for studying short-time scale variability phenomenon, such as the ultraviolet explosive events first reported by Brueckner & Bartoe (1983). In July 1996, we obtained data with SUMER (Wilhelm et al. 1995) onboard SOHO at several locations on the solar disk using two different modes of operation; i) a sit-and-stare mode; and ii) rastering. Each used a 1 × 120 arcsec slit. Here we report two datasets; the first was taken in an active region in the resonance line of O\textsc{vi} 1032Å on July 10 1996 and the other taken on July 14 1996 in a northern polar coronal hole region. The observing sequence for the latter dataset involved the resonance line C\textsc{iv} 1548Å. The purpose for obtaining this data was to provide input for an explosive event modelling programme which is the subject of a companion paper (Sarro et al. 1998).

2. Observational Data

The first observational dataset reported was obtained on 10 July 1996 in a active region with the centre of the image at \(X = 600\) arcsec, \(Y = -200\) arcsec. The experiment was designed so as to record the spectral line O\textsc{vi} 1032Å using a 15 sec integration time. After each integration, the slit was stepped 1 arcsec eastward, accumulating a \(30 \times 120\) arcsec\(^2\) image in 8 minutes.

The other dataset was obtained on 14 July 1996 in a northern coronal hole with the centre of the image at \(X = 2\) arcsec, \(Y = 909\) arcsec. Thus the end of the slit extended to the limb. The experiment was designed so as to record C\textsc{iv} 1548Å using a 20 sec integration time. After each integration, the slit was

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Figure 1. A time series for an explosive event observed in C iv 1548Å in a northern coronal hole on 14 July 1996. (An interactive version of this figure is contained on the CD ROM.)
Figure 2. A time series for an explosive event observed in O vi 1032Å in an active region on 10 July 1996 from 07:25:22 to 07:27:24 UT.

again stepped 1 arcsec eastward, accumulating a $30 \times 120$ arcsec$^2$ image in 10 minutes.

3. Results

3.1. Coronal Hole .... C iv

The sequence in Fig. 1 lasts 220 sec. In the first two time frames we see a broadening of the C iv line centered at 909 arcsec north of disk center. By the third time frame we see the beginning of a blue-shifted component. For the next 40 sec, the line is mostly blue-shifted although there is a weak red-shifted feature. At 120 sec after the start, we see another sudden injection of energy resulting in a large blue and red-shifted plasma. By this stage the center of the feature has drifted southward by three to four arcsec. The latter three time frames show mostly a blue shifted plasma. The size of the explosive event in the north-south direction is $\sim 5$ arcsec. The time frames in Fig. 3 are separated by 1 arcsec (moving eastward), thus the feature is visible over area of $5 \times 9$ arcsec$^2$. 
Figure 3. A time series for an explosive event observed in O vi 1032Å in an active region on 10 July 1996 from 07:27:54 to 07:31:42 UT. (An interactive version of Figs. 2 and 3 is contained on the CD ROM.)
The maximum velocity of both the blue and red-shifted plasma is \( \sim 120 \text{ km s}^{-1} \).

3.2. Active Region \( \text{OVI} \)

The explosive event sequence in Figs. 2 and 3 lasts for over 4 minutes. In the second time frame (07:25:38UT) we see a brightening to the blue at \(-457\) arcsec, this slowly fades until 07:26:39UT where we see a broaden (blue and red) line profile. The mass motion suddenly increases to a velocity of \( > 250 \text{ km s}^{-1} \) in both the red and blue by 07:26:54UT, remaining at this velocity for \( \sim 30\) sec. By this time the center of the mass flow component has moved by \( \sim 4\) arcsec southward. At 07:27:56UT, all we have left is a blue-shifted plasma moving at \( \sim 180 \text{ km s}^{-1} \), slowly fading until 07:28:40UT where we once again have a small red and blue broadened line profile. At 07:28:55UT there is another sudden injection of energy, with plasma again moving both red-ward and blue-ward at a velocity up to \( \sim 250 \text{ km s}^{-1} \). By 07:29:41UT, the major component is blue-shifted at close to \( 300 \text{ km s}^{-1} \). Fifteen seconds later this has almost decayed. The latter time frames also showed a movement southward by another \( 3\) arcsec.

At 07:30:26UT two explosive events take place simultaneous at \(-431\) and \(-437\) arcsec, with the maximum velocity being \( \sim 200 \text{ km s}^{-1} \) in both the blue and red direction. By 07:31:27UT, both events are gone.

4. Future Work

The next stage in the analysis of these datasets will be to use the simulations as discussed in the companion paper by Sarro et al. (1998) to derive a physical insight to the events. The simulations can be carried out for different energy input, different loop lengths, different locations within the atmosphere, etc, thus allowing an estimate of the energy requirements.

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References