EXPLOSIVE EVENTS OBSERVED BY SOHO

R. Erdélyi1, J.G. Doyle2, E.P. Perez2
1School of Mathematical and Computational Sciences, Univ. St. Andrews, North Raigh, St. Andrews, KY16 9SS, Scotland
2Armagh Observatery, College Hill, Armagh, BT61 9DG, N. Ireland

ABSTRACT

The successful launch of SOHO gives new opportunities for studying phenomena on rapid time-scale variability, such as the UV transition region explosive events. In July 1996, we obtained data at several locations on the solar disk using two different modes of operation. Each used a 1×240 arcsec slit. Data were taken on July 14 1996 in the Northern coronal hole region. The observing sequences involved C IV 1548Å and Si II 1533Å in a raster mode using 10 sec integrations. Other sequences were taken on different days involved N V 1238Å, C II 1335Å and the O IV electron density diagnostic lines at 1400Å. The ultraviolet explosive event reported here lasted over 2 mins and was detected in a region within the northern coronal hole. The event first showed a mass up-flow, followed by blue and red-shifted plasma, then finally a red-shifted plasma. Velocities reached ∼ 120 km s⁻¹. A comparison study (see Sarro et al 1997) reports on recent numerical simulations of explosive events.

Key words: coronal heating; SOHO; explosive events

1. INTRODUCTION

Observations in high resolution ultra-violet (UV) spectra taken with the High Resolution Telescope and Spectrograph (HRTS) reported transient brightenings – often referred as explosive events. A statistical analyses of the HRTS-3 mission was reported by Brueckner & Bartoe 1983Dere et al. (1989). Similar observations have been done by SME UVSP which observed line broadenings in ‘hotter lines’ associated to neutral lines in magnetic bipoles (see e.g. Porter et al. 1987).

Generally the regions of explosive events were spatially small, although not point-like. In fact some showed considerable spatially structure. All however showed a sudden enhancement in the ultraviolet line intensity associated with strongly broadened non-Gaussian line profiles. These Doppler broadenings were detected in lines produced by ions formed at temperatures between 20,000–200,000K. The average maximum velocity was 110 km s⁻¹ with a full width at half maximum along the slit of 1600 km. These events were observed in both the ‘quiet’ Sun and in coronal holes, the birthrate being 2–3 less in coronal holes.

With the launch of SOHO new opportunities have become available for studying short-time scale variability phenomenon, such as these explosive events. In July 1996, we obtained data with SUMER (Willhelm et al. 1995) 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 on a dataset taken on July 14 1996 in a northern coronal hole region in the resonance line C 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 1997).

2. OBSERVATIONAL DATA

SUMER is a normal incidence spectrograph operating over the wavelength range 400Å to 1610Å. The off-axis parabola mirror is movable in two dimensions around the focal point allowing pointing of the instrument independent of the spacecraft pointing. Four slits are available: 4×300, 1×300, 1×120 and 0.3×120 arcsec. For the data obtained on July 14 1996 we used the 1×120 arcsec slit. Both 1st and 2nd orders are superimposed on the detector, with the dispersion in wavelength varying from 45mÅ/pixel (1st order) to 22.5 mÅ/pixel (2nd order) at 800Å to 41.8 mÅ/pixel and 20.9 mÅ/pixel at 1600Å. The detector (see Siegmund et al. 1994) has 1024 spectral pixels and 360 spatial pixels. The central area is coated with KBr which increases the quantum efficiency by an order of magnitude in the range 900Å to 1500Å.

The dataset were obtained on 14 July 1996 in a northern coronal hole with the centre of the image at X=2 arcsec, Y= 909 arcsec (see 1). Thus the end of the slit extended to the limb. The experiment was designed so as to record first, C IV 1548Å using a 20 sec integration time. After each integration, the slit was again 1 arcsec eastward, accumulating a 30 × 120 arcsec² image in 10 minutes.


© European Space Agency • Provided by the NASA Astrophysics Data System
For the SUMER instrument, the process of data reduction involves three main steps; flatfielding, de-stretching and radiometric calibration. Our datasets were automatically flat-field corrected on board SUMER. However, due to confused information in the headers of some files, we spent some time checking that this was the case. This was achieved by averaging all the raster images in our files, and then dividing in the SUMER flat-field for that date into the averaged image. No improvement was found implying that flat-fielding was properly carried out on-board the satellite. Destretching of the SUMER datasets is necessary, particular for the data towards the end of the slit due to various wavelength and spatial distortions in the detector. After ruling out unusable files, due to errors in the headers, bad data, etc., all the images obtained at different scans positions (for a determined wavelength range and solar position) were averaged in order to improve the signal to noise. Due to problems towards the end of the slit, only the spatial pixels [26,310] were considered in deriving the averaged spectrum. No radiometric calibration was carried out on these particular datasets as this was not required since we are interested in line shifts. The above corrections were largely done using standard IDL routines from within the SUMER software tree.
Figure 2. A time series for an explosive event observed in C IV 1548 Å in a northern coronal hole on 14 July 1996.
3. CORONAL HOLE IN C IV

The sequence in 2 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 a sudden 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 2 are separated by 1 arcsec (moving eastward), thus the feature is visible over area of $5 \times 9$ arcsec$^2$. The maximum velocity of both the blue and red-shifted plasma is $\sim 120$ km s$^{-1}$.

4. DISCUSSION AND CONCLUSIONS

The objective of the present observational programme is to provide data for a new modelling programme concerned with understanding better how these events happen and their overall contribution to coronal heating. The events are simulated in one-dimensional semi-circular magnetic flux tubes (see e.g. Sterling et al. 1991, citesar97. The length of the loop was taken to be 22,000 km, with a 2200 km thick chromosphere at both ends of the loop. Early results indicate a sudden deposition of energy below the transition region on one side of the loop resulting in the ejection of cool, dense gas bullets, thus the generation of sound waves. Following, the interactions between the cool gas bullets and sound waves (which develop into shock waves), we have the appearance of 'new' transition regions, moving at different velocities. For more details see Sarro et al 1997 in this Volume.

ACKNOWLEDGEMENTS

R.E. would like to thank M. Kéray for patient encouragement. R.E. also thanks the support from PPARC (Particle Physics and Astronomy Research Council) of United Kingdom. Research at Armagh Observatory is grant-aided by the Dept. of Education for N. Ireland while partial support for software and hardware is provided by the STARLINK Project which is funded by the UK PPARC. E.P.P. is supported via a studentship from Armagh Observatory. This work was partly supported by PPARC grant GR/K43515.