ULTRAVIOLET BRIGHTENINGS IN ACTIVE REGIONS
AS OBSERVED FROM OSO-8

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Abstract. Repeated raster images of solar active regions taken at the line centers of the Si IV and C IV resonance lines using the University of Colorado (CU) ultraviolet spectrometer aboard OSO-8 reveal dramatic transient brightenings of up to factors of 10. These brightenings last several minutes and frequently show a repetitive character. Inspection of simultaneous Hα flare patrol records show that these transition zone events are often associated with subflare-like brightenings in the chromosphere. These observations indicate that direct excitation or heating of material already at transition zone temperatures caused by non-thermal particle streams is inadequate to explain the degree of brightening of these lines. The measurements suggest that some process that enhances density of material at $\sim10^5$ K is occurring during these events.

1. Introduction

The advent of solar flare observations at X-ray wavelengths from satellite and rocket-borne instruments has indicated that the seat of a solar flare resides in the corona rather than the chromosphere or below (Švestka, 1973). Common early manifestations of a solar flare include rapid increases in the soft or thermal X-ray flux from the corona (cf., Vorpal, 1976) coincident with the optical brightening in the chromosphere. The mechanism (or mechanisms) by which the X-ray event develops from a high temperature thermal and energetic non-thermal plasma in the corona down to the chromosphere, where it dissipates a large fraction of its energy, is important to the understanding of the overall character of the flare event. The emission lines in the UV solar spectrum that arise from ionic species occurring in the temperature range $10^4$ to $10^6$ K, the ‘transition zone lines’, provide powerful diagnostic probes for the transfer of energy from the high temperature plasma to its dissipation in the chromosphere.

In this paper we report observations of transient brightenings in the transition zone resonance lines of C IV and Si IV observed in active regions with the University of Colorado high-resolution ultraviolet spectrometer aboard the Orbiting Solar Observatory (OSO-8). We show association of many of these brightenings with subflare-like brightenings in Hα, and, in addition, we present associated X-ray, radio, and supporting UV observations concurrent with the events. These observations provide the basis for a general discussion of flare models.

2. Observations

Bruner et al. (1976) and Bruner (1977) have described the instrumentation of the University of Colorado spectrometer aboard OSO-8. The observations presented
here were made between November 1975 and May 1976. The basic observational
data consist of repeated raster images of an active region over the duration of an orbit
taken with the spectrometer centered upon either Si iv λ 1393.8 or C iv λ 1548.2
with a bandwidth of about 0.02 Å. The small, fine-grid, fast spacecraft raster mode
used for these observations produced every 82 s a raster image 15 raster lines high by
16 gate times wide, over an area 2.34 by 2.75'. Since the slit used is 19" long, each
raster pixel is 19 by 10", and each raster line overlaps somewhat with the raster line
above and below.

3. Results and Relationship to Other Data

The intensity variations of raster elements in Figure 1 show the most prominent
brightenings, along with correlative data from radio, X-ray, Hα patrol, and, when
available, OSO-8 observations from the complementary ultraviolet spectrometer
experiment of the Centre National de la Recherche Scientifique (CNRS) (Artzner et al.,
1977). These four orbits constitute all of the data of this type that exhibit
significant intensity changes. The paucity of data is primarily due to the extremely
low level of activity during the OSO-8 mission. The X-ray data shown in Figure 1 is
from the Lockheed Mapping X-Ray Heliometer aboard OSO-8. The radio and Hα
patrol data are taken in part from the compilation of Solar Geophysical Data. In
three of the orbits (20 November, 1975; 30 March, 1976; 7 April, 1976) we were
able to examine the Hα patrol films directly, and Figures 2 and 3 present selected
raster images and corresponding Hα patrol images for selected times during the first
two of these orbits. The outlines of the raster areas drawn on the Hα images in
Figures 2 and 3 are accurate to about 0.3', or roughly the size of the raster pixel. The
Hα patrol images reveal some brightenings in the raster areas that are not
documented as subflares in the Solar Geophysical Data, and frequently these
brightenings correspond with those seen in the transition zone lines. The numbered
arrows on these images follow the development of the brightenings in both the
transition zone images and the Hα photographs. The continuous movies of the raster
images show both subtle brightenings (not enumerated with arrows on Figures 2 and
3) and migration or spreading of the EUV emission from the location of the initial
brightening to surrounding raster elements.

The 20 November 1975 UV event was in progress at the time of spacecraft sunrise.
This time corresponds very well to the onset of Hα enhanced emission from the
patrol films (event 1). About 15 min after the onset of the Hα subflare, a secondary
brightening occurred in Si iv (event 2) which may correspond to the small, bright
knot seen in the Hα photograph at 1503 UT. Passage of the spacecraft through the
South Atlantic Anomaly prevented useful Si iv observations from 1508 to 1527 UT,
but when observations were resumed, we observed an impulsive brightening at about
1536 UT. The Hα patrol was interrupted from about 1524 to 1539 UT by clouds, but
a brief resumption of the Hα data at 1539 UT shows a transient bright knot (event 3),
again at nearly the same location as event 2.