Hα and Soft X-ray Activities in NOAA 7321 Region during 26-28 October, 1992

Yoshinori Suematsu and Nobuyuki Tanaka

National Astronomical Observatory, Mitaka, Tokyo 181, Japan

Abstract

We report some characteristics of the active phenomena which took place in the active region NOAA 7321 between 26 and 28 October, 1992, using Hα data from Mitaka flare patrol system and soft X-ray data from SXT/Yohkoh in addition to GOES X-ray data. It is shown that most Hα events well coincide with corresponding soft X-ray events, and that radiation energy in Hα is comparable to or greater than that in soft X-ray.

1. Introduction

The active region NOAA 7321, which appeared in the end of October, 1992, showed moderate activity (cf. other papers in this proceedings), and were observed with the soft X-ray telescope (hereafter referred to as SXT) on board Yohkoh satellite (Ogawara et al. 1991 and this proceedings) and a new flare patrol telescope at Mitaka (Tanaka et al. 1993).

We investigated this active region with aim of making clear the relationship between the soft X-ray and Hα activities. This type of investigation had been made before by Teske (1971) for minor activities on the limb and by Thomas and Teske (1971) for flares. Although their X-ray instrument had no angular resolution (OSO-III satellite), they found good time-association and good correlation in radiation flux between the soft X-rays and Hα activities. Since the SXT has good angular and time resolution (Tsuneta et al. 1991), we may have opportunity to make the relationship confirmative and further to find out the mechanisms of activities.

The SXT has been confirmed to be sensitive enough to detect small-scale coronal activities of the thermal energy less than 10^{28} ergs (e.g. Shimizu 1992, 1994; Shimizu et al. 1992, 1994) and it was turned out that some of them are spatially associated with Hα brightenings (e.g. Suematsu et al. 1994).

2. Hα and Soft X-rays Data

In real-time operation, the new Hα flare patrol system at Mitaka, which consists of 4-cm doublet, a Lyot filter of passband 0.5 Å, CCD camera, and a personal computer, provides us a time plot (four sec interval) of the ratio of Hα maximum intensity on the solar disk to the average intensity of its surrounding quiet region, the coordinate of the maximum intensity point, and also digitized Hα solar disk images at one min intervals (Tanaka et al. 1993). The intensity resolution is of 8 bits and one pixel size corresponds to about 5 arc sec. The Hα time plot turned out to be very powerful in detecting solar active phenomena.

For further analysis, we use the stored images of one min time resolution. The Hα disk images were corrected for center-to-limb variation, when the intensity ratio is calculated. The Hα intensity was normalized with an average intensity over a wide region around the disk center, excluding dark filaments and bright regions; therefore, the intensity of quiet region at disk center is unity by definition.

Regarding Hα radiation energy, excess Hα flux was calculated by summing the intensity larger than a threshold intensity, and subtracting the threshold intensity. The Hα excess flux was compared with soft X-ray flux from GOES.

Finally, the Hα images were coregistered with SXT/Yohkoh images (Figures 1a-b), using positions of sunspots, in order to compare the location of Hα brightenings and their spatial scales with those in SXT. In this analysis, we mainly used SXT partial frame images (64×64 pixels) of 5.2 or 2.6 arcmin square field of view, taken through thin Al filter effectively sensitive in the wavelength range of 5 to 15 Å.

3. Results

Figure 1 shows the evolution of active region NOAA 7321 in soft X-rays by SXT and Hα from 26 to 28 October, 1992. In early time of Oct. 26, the active region corona consisted of several separate loops lying mostly in the north-south direction. Some of the loops get brightened later on and the overall coronal structure changes; some of the loops disappeared out and the others changed the directions of axes. It should be noted that Hα bright regions correspond to footpoint regions of the coronal loops.

When the coronal loop brightened, the corresponding footpoint region in Hα get brightened too (e.g. 02:29:01 UT)

On Oct. 27, the active region corona looked quite different from Feb. 26, although Hα bright structure looked similar on both days. The coronal loops got highly sheared and weaved. It is likely that the loop in the west (righthand side of the figure) was expanding to the west. One can find out many brightening events this day (see Figure 2), including two GOES M1-class flares. The restructuring and activities of the active region continued on Oct. 28.

Figure 2 gives time plot of excess Hα flux from NOAA 7321 region and soft X-ray flux in 1 to 8 Å band from GOES satellite on 27 October. Note that the latter flux comes from the entire sun.

The Hα flux coinside very well with soft X-ray flux not only on the time variation but also on its amplitude. In the large flares, Hα flux tend to be lower than the soft X-ray flux. This could be due to the narrow passband (0.5 Å) of the Hα filter; some of flare emission can escape away from the passband.

In close look at the time-plot, we perceive that some brightening in Hα are almost missing in the soft X-rays. For instance, the Hα event at 04:15 UT in Figure 2 is very weak in the soft X-rays. In this event, we found that the bright structure in Hα, which looked like a crescent, was quite similar to that in SXT images. This implies that energy release responsible for this event took place in the low corona or possibly in the upper chromosphere.

For the coronal events equal to or smaller than GOES C-class, in general, the excess Hα flux defined here tend to be much larger than the soft X-ray flux in 1–8 Å band, when the apparent structures are quite similar each other, suggesting low-corona events. On the other hand, the Hα flux is comparable to the soft X-ray flux in the case of high-corona events, in which Hα brightenings appear at a few footpoints of brightened coronal loops. We will need much more data to make the results confirmative and quantitative.

We like to note that detailed analysis of Hα data will be very helpful to detect and study soft X-ray activities in the corona.

We would like to thank the entire SXT/Yohkoh teams for providing us the data and data analysis softwares. We are also grateful to the staff of Solar Physics Division, National Astronomical Observatory, for the routine observation of Hα flare patrol.

References

Ogawara, Y. et al. 1991, *Solar Phys.* **136**, 1.
Shimizu, T. 1992, Master Thesis, Department of Astronomy, The University of Tokyo
Shimizu, T. 1994, this proceedings.
Shimizu, T. et al. 1992, *Publ. Astron. Soc. Japan* **44**, L147.
Shimizu, T. et al. 1994, *Astrophys. J.*, in press.
Suematsu, Y. Shimizu, T. and Tanaka, Y. 1994, in "The New Solar Physics from YOHKOH", eds. by Y. Uchida et al., University Academy Press Japan, in press.
Tanaka, N., Suematsu, Y., and Yamaguchi, K. 1993, *Rep. Nat. Astron. Obs. Japan*, **1**, .
Teske, R.G. 1971, *Solar Phys.*, **21**, 146.
Thomas, R.J. and Teske, R.G. 1971, *Solar Phys.*, **16**, 431.
Tsuneta, S. et al., 1991, *Solar Phys.* **136**, 37.

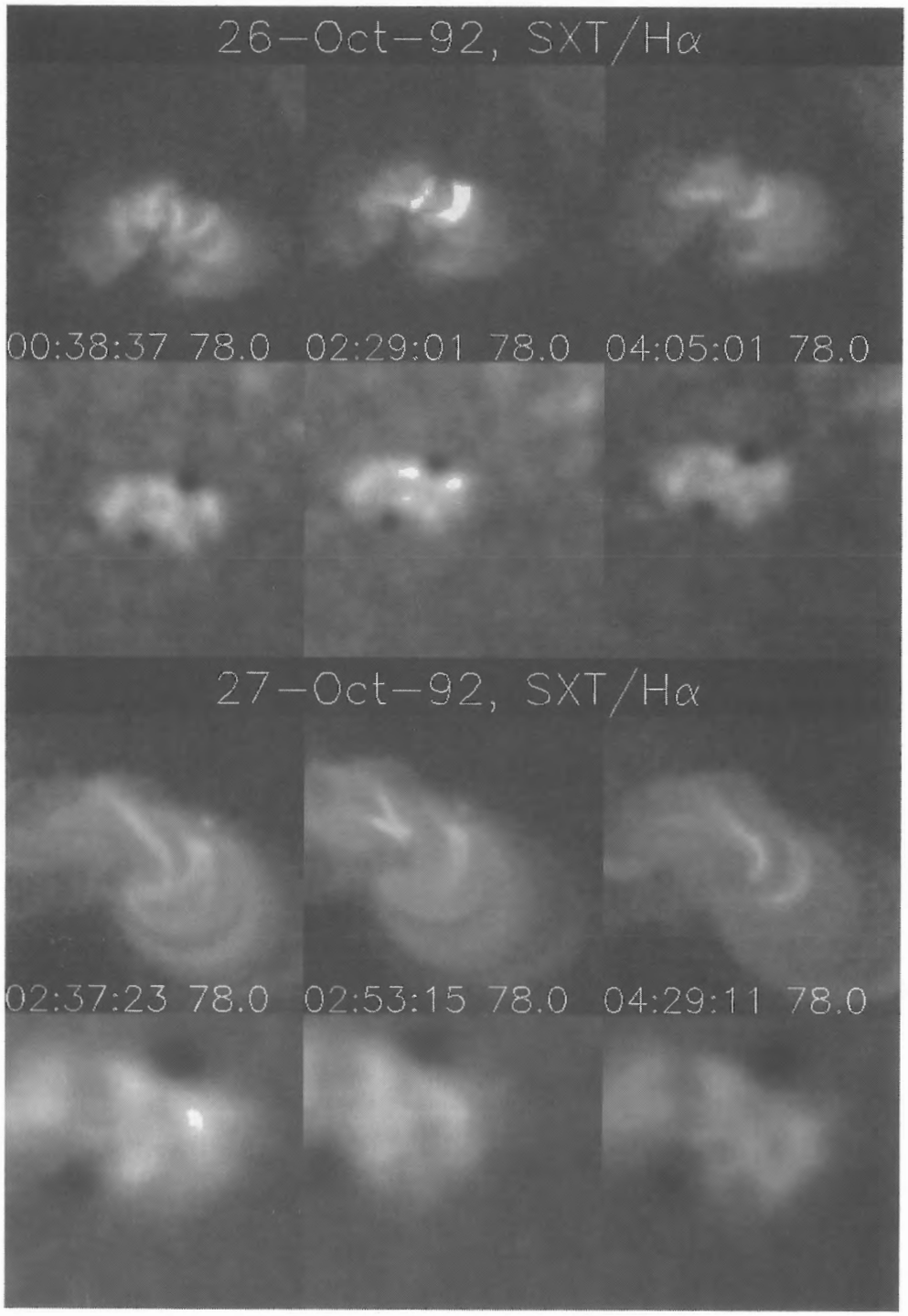

Figure 1a. Evolution of the active region NOAA 7321 in soft X-rays through thin Al filter of SXT (upper row) and in Hα (lower row) on 26-27 October 1992. The observed time in UT and exposure time in msec for soft X-rays are given in each soft X-ray sub-images. The field of view is 5.2 arcmin square for Oct. 26 and 2.6 arcmin for Oct. 27, respectively.

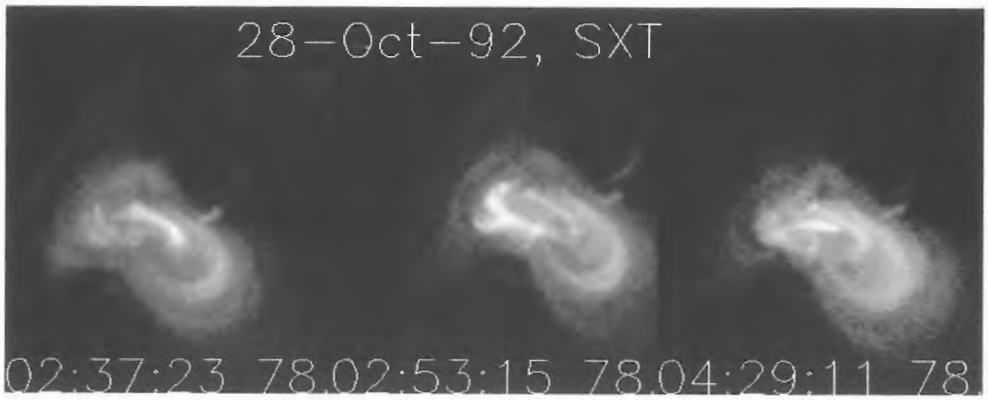

Figure 1b. Evolution of the active region NOAA 7321 in soft X-rays through thin Al filter of SXT on 28 October 1992. The observed time in UT and exposure time in msec are given in each sub-images. The field of view is 5.2 arcmin square.

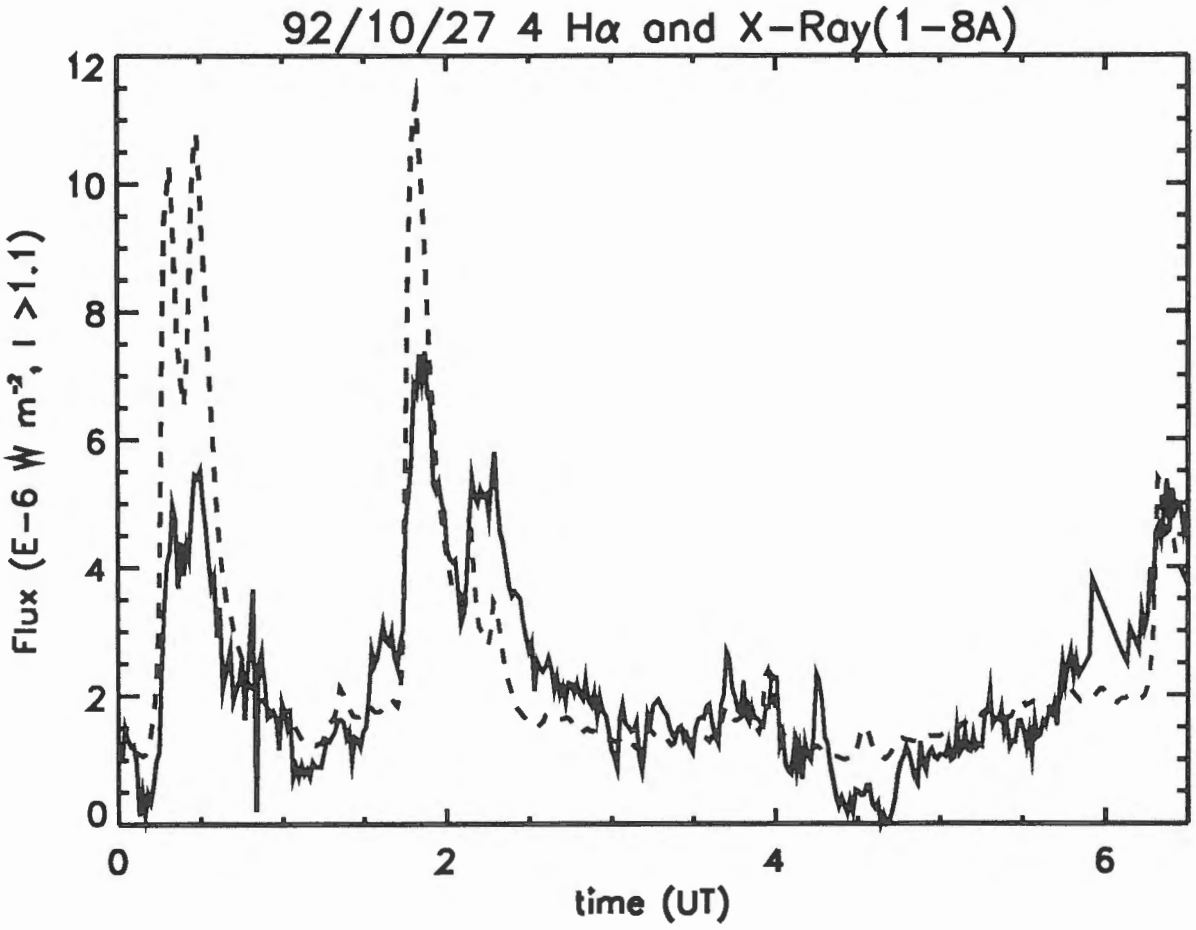

Figure 2. Time plot of excess Hα flux through 0.5 Å passband (solid line) from the active region NOAA 7321 and soft X-ray flux in 1–8 Å channel of GOES (dashed line) from the entire sun on 27 October 1992.