# FLARES ON SEPT. 6, 1992 IN NOAA 7270: SXT OBSERVATIONS AND COMPARISON WITH H ALPHA AND HXT OBSERVATIONS

K. Shibata[1], N. Nitta[2], R. Kitai[3], H. Kurokawa[3], K. Yaji[1], T. Sakurai[1], and H. Zhang[4]

[1] National Astronomical Observatory, Mitaka, Tokyo 181, Japan
[2] Lockheed Palo Alto Research Laboratory, Palo Alto, CA 94304, U.S.A
[3] Kwasan and Hida Observatories, Kyoto Univ., Kamitakara, Gifu 506-13, Japan
[4] Beijing Astronomical Observatory, Chinese Academy of Sciences, Beijing 100080, China

## Abstract

The soft X-ray images of four M-class flares in the active region NOAA 7270 on Sep. 6, 1992, taken with *Yohkoh* soft X-ray telescope (SXT) show that these flares consist mainly of *single bright loop*, suggesting that these flares might be classified as *simple loop flares*. H$\alpha$ images taken at Hida observatory (Kitai 1993), however, show entirely different features; i.e., at least three of these four flares (1:58 UT, 5:13 UT, 6:51 UT) show vigorous filament (or spray) eruptions, suggesting these flares should be classified as *eruptive (or ejective) flares* or *two ribbon flares*. Detailed comparison between SXT images and H$\alpha$ images leads us to conclude that *it is very dangerous to determine the type of flares only from SXT images*, and casts a doubt for the existence of *simple loop flares*. The comparison with *Yohkoh*/HXT data is also briefly mentioned.

## 1. Introduction

The active region NOAA 7270 produced many flares during Sep. 5 - 7, 1992. Among them, 4 M-class flares have been observed by *Yohkoh* and by ground based observatories in Japan. The purpose of this short note is to report on preliminary results of morphological studies of these four flares. We will describe morphological evolution of four M-class flares in SXT (soft X-ray telescope) images and compare them with H$\alpha$ images taken at Hida Observatory (Kitai 1993) and *Yohkoh*/HXT (hard X-ray telescope) images (Yaji 1993). The white light images and magnetograms taken at Mitaka (Sakurai 1993) and Huairou (Zhang 1993) are also used to make clear the relation between the neutral line and flaring loops.

## 2. SXT Observations

### *2.1. M1 flare at 1:58 UT*

This flare occurred near the southern spot of NOAA 7270. The HXT (low channel) intensity increased much during 1:57 and 1:59, showing an impulsive nature of this flare. A bright single loop appeared in SXT images at around 1:58 over a neutral line. One transient soft X-ray bright point was seen on the southern outer edge of active region between 1:55 and 2:01. The direction of the loop was initially oblique to the neutral line (at 1:58), but gradually became perpendicular to the neutral line at 2:24 (i.e., the loop evolved to non-sheared geometry).

### *2.2. M1.1 flare at 2:23 UT*

This flare occurred near the west-north spot. The light curve of the HXT (L) has shown that this flare is similar to the LDE (=Long Duration Event) flare, though the time scale of the flare is not long (less than 16 min based on HXT light curve). A bright simple loop appeared in SXT images at 2:23 over a neutral line near the west-north spot. The SXT loop evolves to non-sheared geometry well after the flare at 3:30. A faint, cusp-like structure was seen above the compact bright loop at 2:23. A bright point appeared just on the southern footpoint of the single bright loop between 2:23 and 2:25

### *2.3. M2.4 flare at 5:13 UT*

This flare occurred again near the west-north spot. The light curve of the HXT (L) has shown that this flare is impulsive. In SXT images, double bright points appeared at 5:14 UT, and then the loop connecting these two points brightened as a single loop at 5:16 UT (see Fig. 1). The angle between the loop and the neutral line changed with time though the direction is opposite to the previous two flares; in this case, the loop became more oblique to the neutral line (at 5:34). It is also interesting to note that a large scale loop with a faint, cusp-like structure was seen above the compact bright loop in SXT images in late stage. The size of the large scale loop increased with time, and the loop top is brightest.

### *2.4. M1.3 flare at 6:51 UT*

This flare occurred near the southern spot. The HXT (L) light curve shows very impulsive nature during 6:53 and 7:02. The time evolution of morphology of this flare in SXT images is as follows; one bright point appeared at 6:58, and another bright point appeared at 7:00 (see Fig. 2). A faint elongated feature was seen to move westward at $\sim$ 70 km/s in SXT image at 7:00. At 7:03, a single bright loop connecting above two points appeared, and the length and thickness of the loop increased until 7:21.

## 3. Comparison with H$\alpha$ Observations

As we have seen above, the SXT images showed one single bright loop (sometimes with a less-bright point nearby). There was no eruption-like feature in SXT images except for a very faint moving feature found in M1.3 flare at 6:51 UT. These are quite typical structures of the flare observed by SXT (e.g., Acton *et al.* 1992), and one might conclude that flares occurred in quasi-static *simple loops*. However, H$\alpha$ images and movies (Kitai 1993) show that these flares are very different from such quasi-static *simple loop flares*:

In the case of the *M1 flare (1:58 UT)*, an H$\alpha$ filament on neutral lines erupted at 1:57 UT.

A quick look at the *M1.1 flare (2:23 UT)* does not show any eruption feature in H$\alpha$ image, but a close inspection of the H$\alpha$ video movie has revealed that a very faint dark feature erupted from the upper part of the filament at 2:20-2:30.

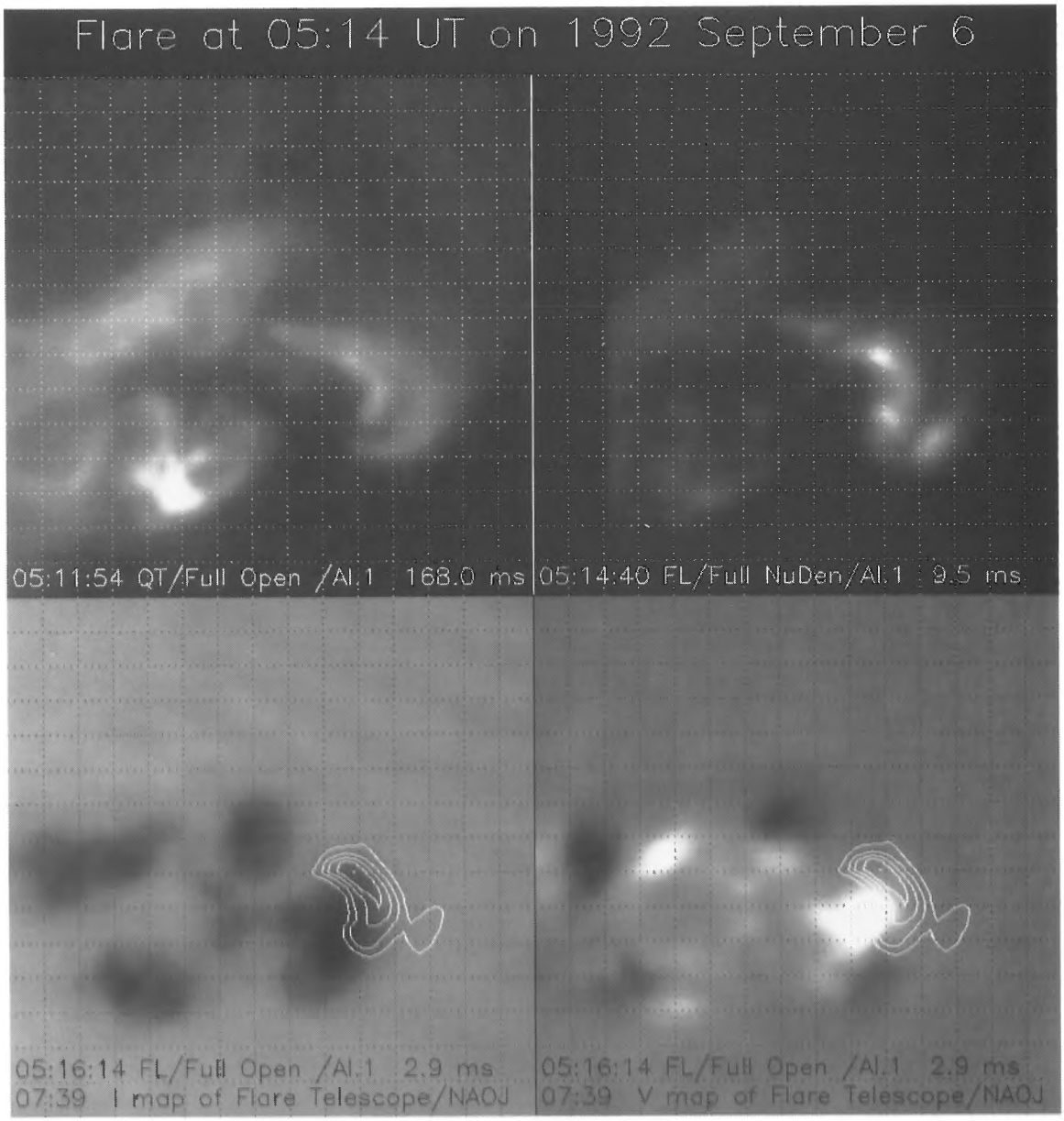


Fig. 1 SXT images of the M2.4 flare at 5:13 UT. Upper left: 5:11 UT (preflare). Upper right: 5:14 UT (impulsive phase); note that double points at the foot of the loop are bright. Lower left: single SXT loop (contour) at 5:16 UT overlaid on white light image at 7:39 UT taken with the Flare Telescope at Mitaka. Lower right: single SXT loop (contour) at 5:16 UT overlaid on magnetogram at 7:39 UT taken with the Flare Telescope at Mitaka.

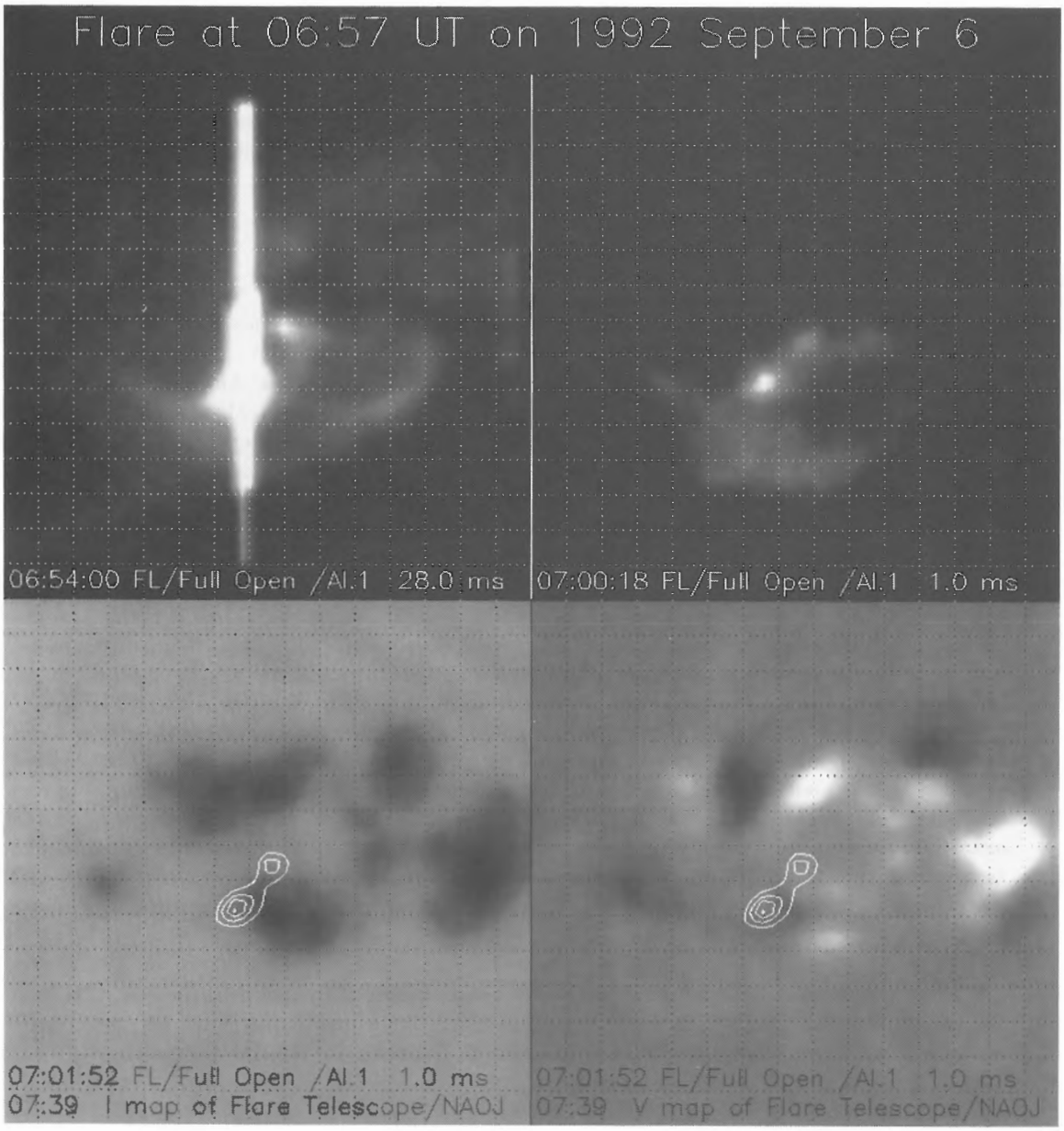


Fig. 2 SXT images of the M1.3 flare at 6:51 UT. Upper left: 6:54 UT (impulsive phase). Upper right: 7:00 UT (impulsive phase); note that double points are bright. Lower left: double points (contour) at 7:01 UT overlaid on white light image at 7:39 UT taken with the Flare Telescope at Mitaka. Lower right: double points (contour) at 7:01 UT overlaid on magnetogram at 7:39 UT taken with the Flare Telescope at Mitaka.

The *M2.4 flare (5:13 UT)* started with the eruption of an Hα filament at 5:13. The velocity of the erupting filament is estimated to be ~ 200 km/s (Kitai 1993). In Hα, the flare was seen as four ribbon flare; each pair of two ribbons corresponds to each pair of footpoints of compact and larger loops seen in SXT.

The *M1.3 flare (6:51 UT)* was associated with a vigorous ejection of Hα dark feature (maybe, filament eruption or spray) at 6:53 UT.

Consequently, three of these four flares were associated with vigorous Hα mass ejection (filament eruption or spray). Even the gradual-type flare at 2:23 was associated with a very faint eruption of dark filament.

## 4. Summary and Conclusion

Table 1 summarizes the morphological characteristics of four M-class flares on Sep. 6, 1992, observed by SXT, HXT (Yaji 1993), and Hα (Kitai 1993). (See Hanaoka 1993, for a summary of radio observations of these flares.)

One apparent, important conclusion of this study is as follows: Although SXT images show that all these four flares consist of single bright loop (often with a less-bright point nearby), Hα images taken by Kitai (1993) clearly showed the vigorous eruption of filament or spray at least for three of four flares. These observations lead us to conclude that *it is very dangerous to determine the type of flares only from SXT images.* This result further casts a doubt for the existence of *simple loop flares.* That is, although SXT images of these four flares show such simple loop-like feature, these four flares are classified as *eruptive (and ejective) flares* or classical *two ribbon flares* if we see corresponding Hα images. Common evolutionary changes, such as apparent relaxation of sheared loop configuration, would be explained by the succesive reconnection between sheared open field lines produced by the filament eruption. Note that similar apparent relaxation of sheared loop configuration has also been found in the flares on Nov. 15, 1991 (Sakao *et al.*, 1992) and on Feb. 6, 1992 (Sakurai *et al.* 1992).

Kurokawa (1993) and Kitai (1993) pointed out that the regions where these four flares occurred correspond to the region of emerging magnetic flux. It is very likely that the filament eruption is triggered by emerging flux. Even a direct interaction between emerging flux and overlying field might play a role in generating flares, because bright loops always appeared near the emerging flux in all four flares. It is suggested that these flares might be classifed as a mixed type of CSHKP (= Carmichael-Sturrock-Hirayama-Kopp-Pneuman) model and emerging flux model (Heyvaerts *et al.* 1977, Shibata *et al.* 1992, Yokoyama and Shibata 1992).

This report is mainly based on the discussion during the small workshop on "flares on Sep. 6, 1992" which was held in April of 1993 at ISAS. We would like to thank all participants of the workshop, especially to Drs. T. Kato and Y. Hanaoka, for fruitful discussion.

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Table I Summary of Observations

| time (UT) | GOES | SXT image | HXT image | Hα | SXT-faint | HXT light-curve |
|---|---|---|---|---|---|---|
| 1:58 | M1 | single loop (+ another point) | double points (+ another point) | filament eruption | – | impulsive |
| 2:23 | M1.1 | single loop | loop | very faint filament eruption | cusp-like structure ? | gradual soft |
| 5:13 | M2.4 | double points ↓ single loop | double points | filament eruption | cusp-like structure | impulsive |
| 6:51 | M1.3 | double points ↓ single loop | point-like ↓ loop | Hα ejecta (spray ?) | – | impulsive |