FLARES ON SEPTEMBER 6, 1992

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Abstract

We present some preliminary results of our observational study of typical eruptive flares in NOAA7270 on September 6, 1992. (1)Magnetic shear and flux emergence are strongly related to flare production. (2)Observed flares showed a common temporal relation between cool plasma dynamics seen in Hα and coronal energy releases seen in YOHKOH data. (3)At the pre-heating stage of flares, there were some indications of slow reconnection of adjacent magnetic loops.

1. Introduction

NOAA7270 produced many M or C class flares on Sep 5-7, 1992. The region grew its area rapidly during this period due to successive emergence of magnetic flux and to proper motions of sunspots, and formed δ type magnetic configurations at 4 parts of the region on Sep 6. All the flares were observed to be related to these δ type magnetic configurations. Here we report the results of Hα optical observation of the eruptive flares on Sep 6, at the DST of Hida. We will also discuss the results of cross-comparative analyses of YOHKOH observations of the flares, especially on the spatial and temporal relations of Hα mass explosion, SXT brightening and HXT bursts during the precursoring or pre-heating stage of the flares.

2. Evolutional Characteristics of NOAA7270

As can be seen in figure 1, NOAA7270 evolved rapidly from Sep 5 through Sep 7. On Sep 5, there appeared an EFR at the northern part of the preceding spot (EFR A). The axis of the EFR was directed nearly along the N-S direction. On Sep 6, the axis of the region rotated in counter-clockwise direction. And the distance between opposite polarities grew

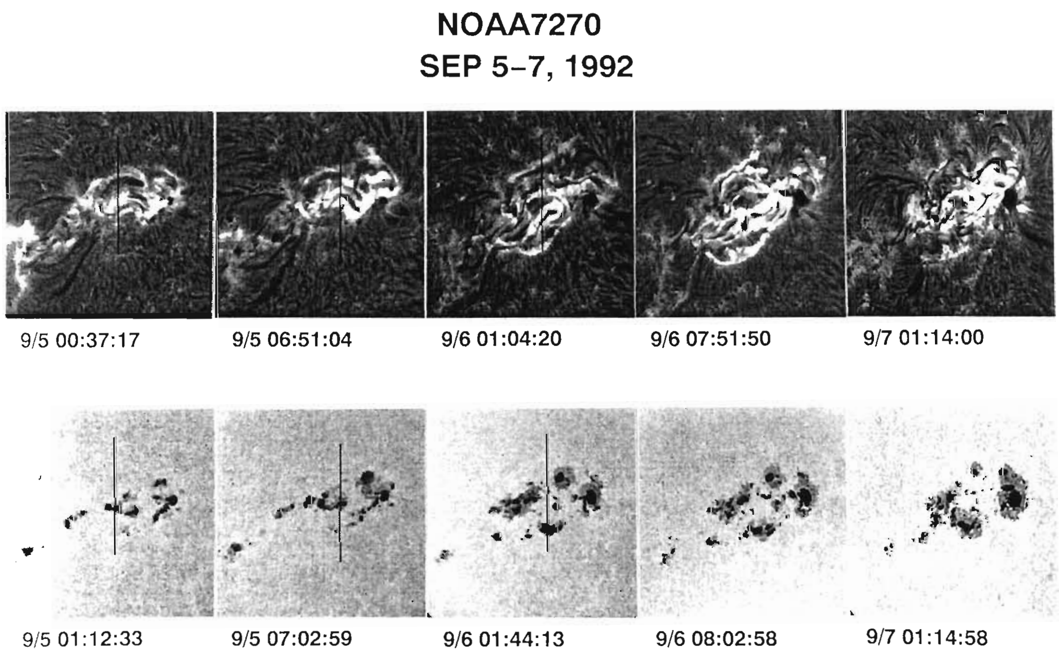

Fig. 1. Temporal evolution of NOAA7270. Upper row : Hα images. Lower row : Continuum images. North is to the top. East is to the left.

rapidly. As a result of these motions of rotation and separation, a highly sheared magnetic structure was formed on Sep 6. M-class flares occurred at this site of the region repeatedly.

The emergence of another EFR (EFR B) was essential to the evolution and the activity of NOAA7270. The EFR B appeared at the central part of NOAA7270, pushing the pre-existing magnetic structures aside on Sep 5-6. The specific character of the EFR was its way of emergence. The magnetic structure was highly sheared since the beginning of the emergence. Hα features in the region were nearly parallel to the magnetic neutral line. This site was also active for producing M-class flares on Sep 6.

3. Flares

On Sep 6, following four M-class flares were observed (figure2):

(1) M1.0/1N flare (0156-0225 UT) : Threads or low-lying filament were observed on a magnetic neutral line in the EFR B region. Part of the filament was highly excited and a bright loop in Hα was observed to expand with a velocity of 200 km/sec at the explosive phase. Following the initial expansion, an arcade system of Hα plasma, possibly situated underneath the covering neutral filament, started to expand. One or two minutes after the first Hα explosion, a hard X-ray burst started. In SXT images, two bright kernels, situated in opposite magnetic polarity regions, were observed at the main phase of the flare.

(2) M1.1/SF flare (0232-0251 UT) : Surrounding the leading spot, there was a system of superpenumbral filaments in highly sheared form in the region EFR A. Parts of the filaments which emanated radially outwards from the leading spot, were gathered to a following spot,

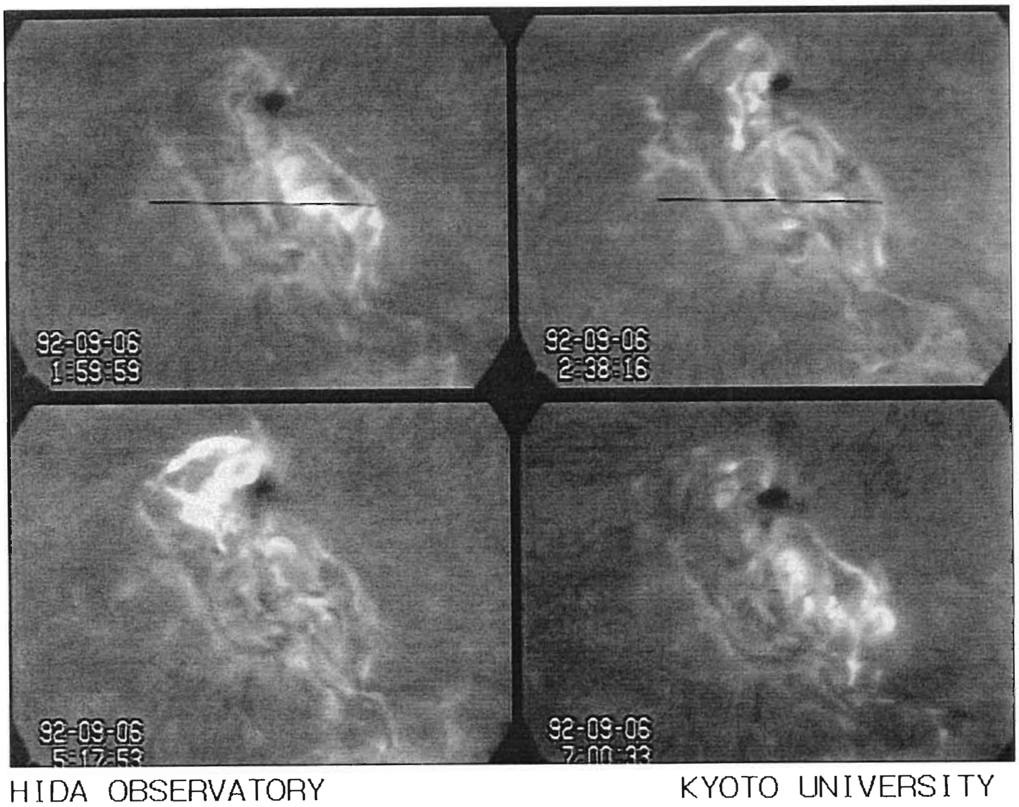

Fig. 2. Hα line center images of the four flares observed in NOAA7270 on September 6, 1992.

forming a twisted bundle of loops in Hα. After about half an hour of internal motions in the twisted bundle, the flare started. The flare itself was of a slow type. Soft X-ray flux increased and then decreased gradually (LDE event). No hard X-ray bursts were detected in this flare.

(3) M2.4/2N flare (B0515-0614 UT) : The flare occurred at the same region as the flare (2) with a similar Hα morphology, but was different from (2) in some respects. The flare firstly brightened at both sides of the neutral filament in Hα. In SXT images of YOHKOH, there appeared a bright loop, parallel to the magnetic neutral line, connecting two-ribbons of Hα bright patches. A filament eruption occurred at the explosive phase. Then there appeared another pair of Hα bright ribbons adjacent to the initial ribbons. A faint loop or a cusped loop in soft-X rays was observed, related to the second two-ribbons. A hard-X ray burst was also observed 1-2 min after the explosive phase.

(4) M1.3/1F flare (B0657-0818 UT) : The flare occurred at the same part as the flare (1) and showed a very similar behavior as the flare (1), though there were some differences in the explosive filament morphology.

4. Discussion

As was stated above, the characteristics of initial time evolution of M1.0/1N flare (0156-0225 UT), M2.4/2N flare (B0515-0614 UT) and M1.3/1F flare (B0657-0818 UT) were very similar to each other. After the pre-heating stages of 5 to 10 min, there came explosive

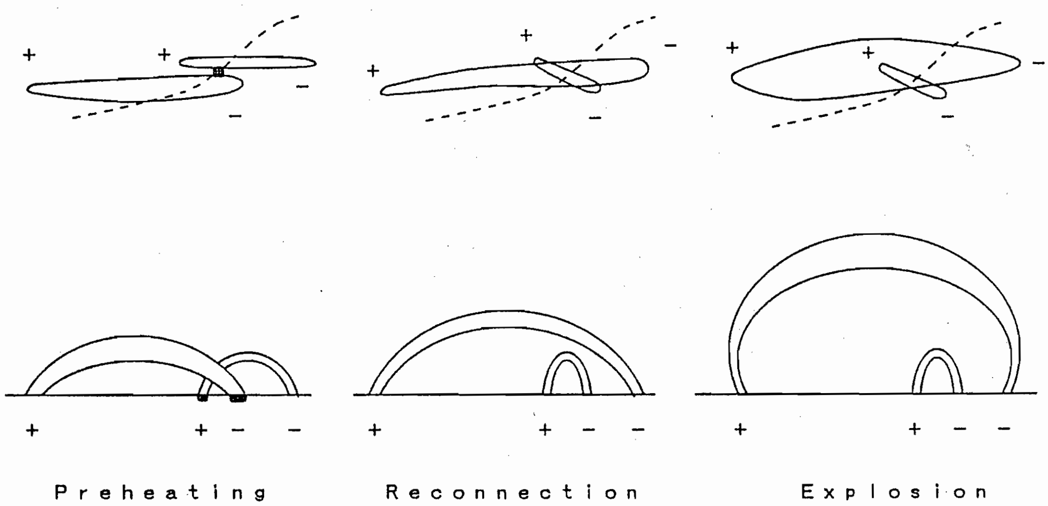

Fig. 3. Top- and side-views of possible magnetic field evolution at initial phases of filament-eruption-flares. Broken lines are magnetic neutral lines.

phases associated with Hα filament eruptions (v(max) $\simeq$ 200 km/s). Then about 1 to 2 min later, hard X-ray bursts started. We think that the observed temporal evolution is typical of erupting flares.

We focus attention on the temporal development of the flare (1) from the pre-heating stage to the filament explosion phase. During the pre-heating stage, two bright patches in Hα increased their intensities gradually. These patches were very compact in size (d $\simeq$ 1"), and were situated near the magnetic neutral line. In SXT images, there existed a compact point-like source in the vicinity of Hα patches (possibly between Hα patches and on the neutral line). Schematic drawing of possible magnetic configuration are given in figure 3.

In highly sheared state of magnetic field, two adjacent magnetic loops reconnect gradually, producing a soft-X source at the reconnecting point and also heating up the chromosphere at the footpoints of reconnected loops. When the reconnection is completed, newly formed longer loops start to explode. This explosion will trigger the main flare.

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