

Soft X-Ray Observations of Eruptive Prominences

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Abstract. Evolution of magnetic structures in the region around an eruptive prominence of August 28, 1992 are examined using soft X-ray images obtained by Yohkoh. The eruption was preceded by the appearance of a large-scale soft X-ray jet which was ejected from near the root of the southern end of the prominence. Changes of magnetic geometry at the southern end of the prominence appeared to trigger the eruption. In the course of prominence eruption, helically twisted soft X-ray loops were observed around the prominence. This indicates that magnetic reconnection of a sheared arcade took place underneath the erupting prominence.

1. A Case Study: The Eruptive Prominence of August 28, 1992

Many eruptive-prominence events have occurred since the launch of Yohkoh in 1991. Among them, some events showed very complicated soft X-ray structures during the course of their eruption. As an example, we discuss the event observed above the eastern solar limb on August 28, 1992. An example of an H_{α} image of the erupting prominence is shown in Figure 1. The latitudinal extent was 15° in projection onto the plane of the sky. According to the H_{α} synoptic map from the Solar-Geophysical Data (NOAA/SESC), the magnetic neutral line underneath the prominence was aligned nearly in the north-south direction, so that we have a side view of the prominence. The prominence did not show appreciable ascending motion when H_{α} observations at Boulder and Holloman were performed at 14–17 UT on August 28. The start time of the eruption must have been between 17 UT and 21 UT on August 28 (the latter time was that of

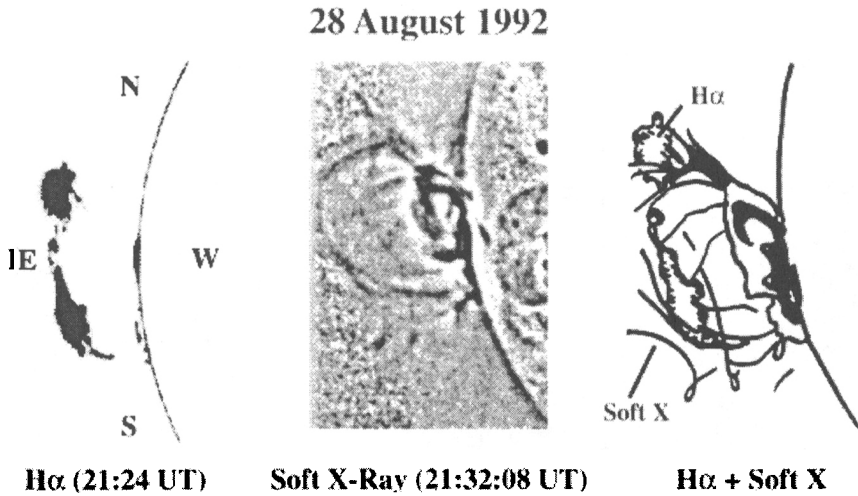


Figure 1. Left: an H α photograph (negative) of the eruptive prominence of August 28, 1992 (21:24 UT) taken at Norikura Observatory. Middle: an enhanced soft X-ray image (negative) taken by the Soft X-ray Telescope of Yokoh (21:32:08 UT). Right: a sketch of the soft X-ray loop structures based on the middle frame. The approximate geometry of the eruptive prominence is also shown in this sketch.

the first H α observation in Japan on this date).

The most remarkable feature, which appeared immediately before the eruption, is the large soft X-ray jet (Figure 2). This jet appeared to have been ejected near the root of the southern end of the prominence at about 18:40 UT. The X-ray intensity of a bright region seen underneath the prominence began to increase after the appearance of the jet. We suggest that this jet, which was unusually large (see Shimojo et al. 1996), marked a precursor event of the prominence eruption. Since the eruption began shortly after the appearance of the jet, the jet may reveal the start of the destabilization of the magnetic structures which supported the prominence.

According to H α observations performed at Mitaka and Hida, the ascending speed of the prominence was 30–60 km/sec. Highly complicated soft X-ray structures, which were observed during the course of the prominence eruption (21:32:08 UT), are shown in the middle frame of Figure 1. A composite sketch of the prominence and soft X-ray loops is also shown in this figure for comparison. The most interesting feature seen in Figure 1 is the presence of kinky loops, which are interpreted as the projected images of helical flux ropes. Straighter loops apparently passing through the center of the helical loops are seen also around the erupting prominence. Although it is difficult to know the 3D configurations of these loops, a combination of helically twisted loops on the outside and straight loops passing through the axis of the helical loops is consistent with the projected view which we observed. This configuration is similar to that proposed by van Ballegooijen and Martens (1989) to create twisted flux tubes

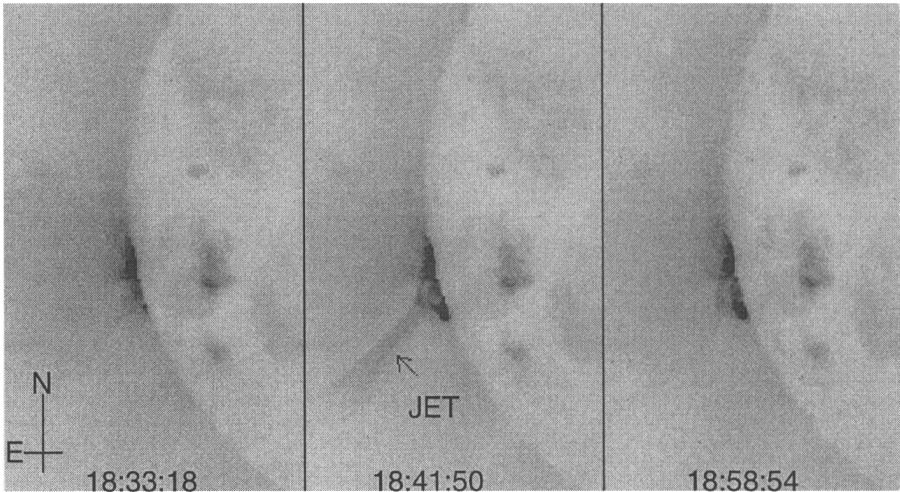


Figure 2. A soft X-ray image (negative) of the jet (18:41:50 UT) which appeared about 3 hours before the prominence eruption. For comparison, soft X-ray images taken immediately before and after the appearance of the jet are also shown.

above the magnetic neutral line. They showed that twisted flux tubes are formed by development of sheared prominence-supporting field due to flux cancellation above the neutral line. They suggested also that prominence eruption can be caused by this process.

2. Concluding Remarks

This event is one of the best examples of prominence eruptions observed by Yokkoh. Since the eruption took place shortly (< 3 hours) after the appearance of the jet, we suppose that the trigger action, required for the prominence eruption, was the change in magnetic structure near the root of the southern end of the prominence. Perhaps emerging flux could have produced this magnetic restructuring, as suggested by Feynman and Martin (1995). The presence of helical loops surrounding the erupting prominence and a bright soft X-ray arcade following it can be explained by magnetic reconnection underneath the erupting prominence (e.g., Hirayama 1974). Further detailed analysis is in progress.

References

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