X-RAY STRUCTURES ASSOCIATED WITH DISAPPEARING Hα FILAMENTS IN ACTIVE REGIONS

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Several studies using data from Skylab instruments have been carried out to determine the spatial and temporal relationships between disappearing Hα filaments and the associated coronal emission features. Webb et al. (1976) studied 30 transient coronal X-ray enhancements which could be associated with the disappearances of Hα filaments outside active regions. They found that in the early phase of the transient X-ray brightening, emitting structures appeared at or near the filament location with shape and size resembling the filament. Sheeley et al. (1975) examined a long-lived X-ray enhancement of expanding loops associated with an active region filament which disappeared. Rust and Webb (1977) found a good statistical correlation in time and position between large scale (length > 60,000 km) active region X-ray enhancements and Hα filament activity, in particular, events of an eruptive nature.

The purpose of the present study is to examine in detail the relationship between active region disappearing Hα filaments and the associated coronal X-ray structures observed both before the disappearance event and afterwards. The results presented here constitute a "first order" overview of the events chosen for study.

The events chosen for study were first selected from a list of active region X-ray transients observed in the images from the AS&E X-ray telescope on Skylab which were the basis of the Rust and Webb (1977) study. Additional events were selected from a list compiled by D. Webb of sudden disappearances of filaments during the Skylab period. Only those events for which an active region filament disappearance could easily be seen in the NOAA Hα patrol films were used. There was a total of 14 events in 8 different active regions.

The event of 29 August 1973 shown in Figure 1 is one of the events studied. Meudon filaments F7 and F8, which are overlain by X-ray loops, remained after the filament disappearance of F6 at ~ 1830 UT. There were no obvious X-ray loops overlying the latter filament.

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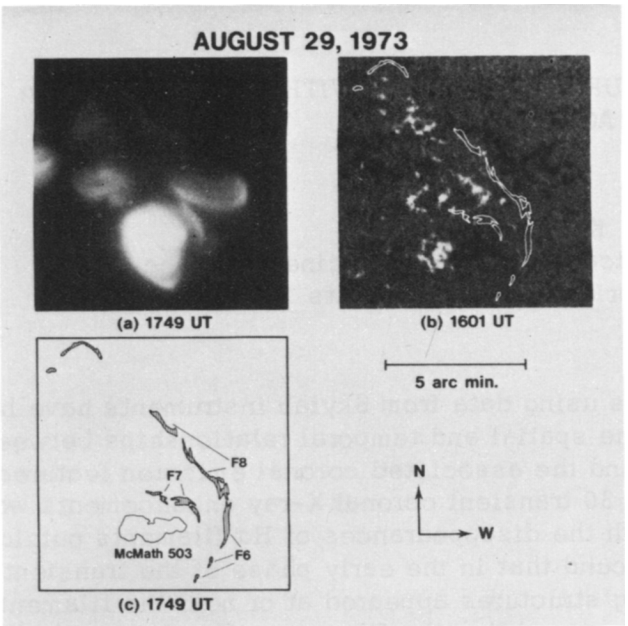

Figure 1. (a) The X-ray structures of McMath 497 and 503 prior to the filament disappearance event of ~ 1830 UT on 29 August. (b) The outline of the Hα filament structure on the aligned daily KPNO magnetogram. (c) Schematic showing Meudon F7 and F8, which remained, and F6, which disappeared. Note that X-ray loops overlie F7 and F8, but not F6.

The event of 3 September 1973 illustrated in Figure 2 shows that we can not in general associate disappearing filaments with a lack of visible associated X-ray loops. In this case a loop lies along both the western part of the filament which disappears as well as the eastern portion which survives. No new X-ray emission feature appears at the site of the remaining filament section, but a new X-ray loop appears along the site of the disappearing filament.

In the first part of the study the 14 events were analyzed for their pre-event spatial associations with X-ray structures. The sections of the filaments that later disappeared were considered separately from the filaments that remained after the events. In each case the associated X-ray structure was classified into three categories: (1) a distinct loop or set of loops; (2) an X-ray cloud with no resolved loop structures; and (3) no obvious X-ray emission observed in photographic images of the thin filter (2 - 32, 44 - 54 Å) 64 sec exposure. In some cases a disappearing or remaining filament was covered by structures of different

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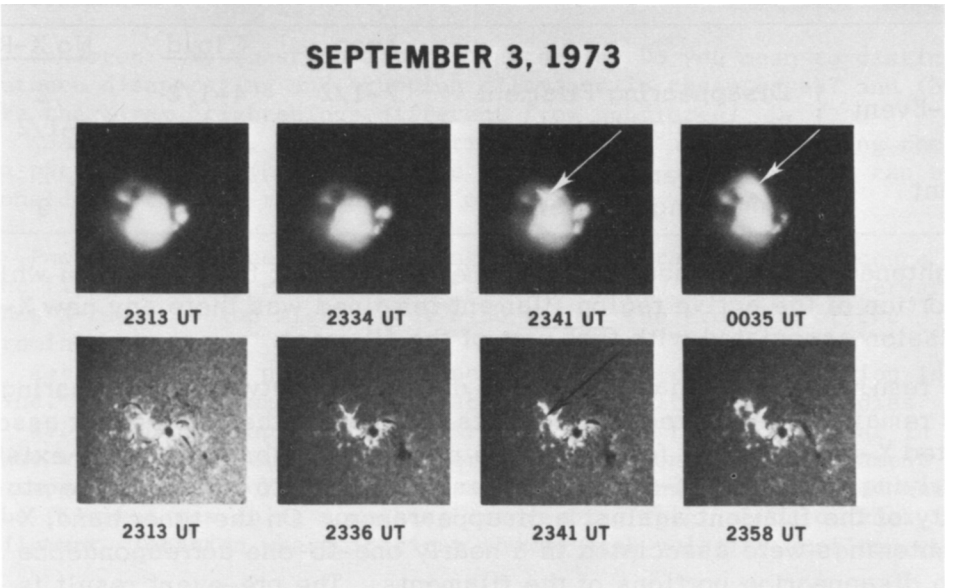

Figure 2 (from Rust and Webb, 1977). Aligned X-ray and Hα images of McMath 510 before and during the disappearance of the western part of the Hα filament on 3 September. A curved loop lies along the entire section of the Hα filament shown at 2313 UT. In the event an X-ray loop (indicated by an arrow) is present at the site of the disappearing filament, but no new X-ray emission is apparent at the remaining filament. Each frame is 15 arc min square.

categories, for example, partially by an X-ray cloud and partially by no emission. In these cases the filament was considered to be half of one category and half of the other. The results of the X-ray associations with the 14 disappearing filaments and the 11 remaining filaments are shown in Table I. It can be seen that within the limited statistics of the study there is little difference between the X-ray features associated with disappearing filaments and those associated with remaining filaments in the same active regions.

The second part of the study has been to examine the X-ray images during a period of 3 hours following the onsets of the filament disappearances. These existed for 10 of the 14 events of the study. In 8 of the 10 cases an X-ray loop structure of some kind brightened spatially close to the site of the disappearing filament, either along or over the magnetic inversion line. In one of the cases where no new X-ray feature was seen, the disappearing filament had completely reformed prior to the time of the first X-ray image of the event, so an X-ray structure may well have

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TABLE I: ASSOCIATION OF X-RAY FEATURES AND Hα FILAMENTS

		Loop	Cloud	No X-Ray
Pre-Event	Disappearing Filament	7-1/2	4-1/2	2
	Remaining Filament	4	4-1/2	2-1/2
Event	Disappearing Filament	8	0	2
	Remaining Filament	0	0	9

brightened and then faded in that time. In none of the 9 cases in which a portion of the active region filament remained was there any new X-ray emission associated with that part of the filament.

The results indicate that there is no distinction between disappearing and remaining active region filaments in terms of their pre-event associated X-ray emission features. The presence or absence of pre-existing overlying or parallel X-ray loops does not appear to influence the stability of the filament against a disappearance. On the other hand, X-ray brightenings were associated in a nearly one-to-one correspondence with disappearing portions of the filaments. The pre-event result is valid only for a characteristic time scale of at least an hour. Martin and Ramsey (1972) found a statistical pattern of filament activity beginning within an hour prior to flares of class 1 or larger. One might then ask whether there is a simultaneous pattern of changes in X-ray features associated with such filament activity. That question will be the subject of future studies.

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DISCUSSION

VanHoven: My question has two parts: (a) Do you mean to distinguish between disappearing and erupting filaments in these cases? and (b) Are the X-ray brightenings different from subflares?

Kahler: (a) No, I cannot distinguish between the two using the NOAA Hα patrol films. (b) Most of the brightenings of this study can be considered to be X-ray subflares or flares.

Pneuman: You seem to be saying that the X-ray emission occurs after the filament disappears. Is there any evidence from your observations that X-ray emission might occur also before the eruption of the prominence?

Kahler: I have not yet examined the data with that question in mind. You should ask David Webb about the results of his studies.

Webb: In the paper by Webb, Krieger and Rust we noted that in every case where we had images during or before the onset of a filament disappearance, we observed a compact brightening at a location where the filament was doing something interesting (e.g., bend or kink in filament, location where it first showed high velocity, motion, etc.).

Uchida: What are the time scales (rise time, duration, fading time scale, etc.) for the X-ray emitting objects appearing after the disappearance of the dark filament?

Kahler: The study was not really designed to answer that question, but I can give you a general idea from this and other studies. At first there may be small loop brightenings, manifested as flares, in which loops are bright with lifetimes on the order of 1-3 x 10 min. There are also often larger scale loops observed later which constitute the long decay events lasting for perhaps hours.

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