FLARING ARCH STRUCTURE OF LARGE ERUPTIVE PHENOMENA AND RIGID ROTATION

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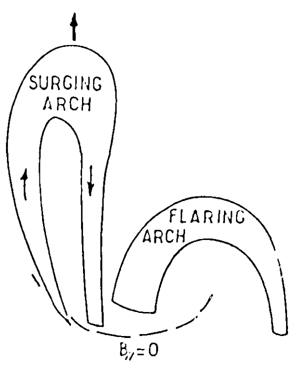
ABSTRACT - Considering the flaring arch to be the basic element of all flares, we study here the structure of compact flares and double ribbon flares. It is observed that, in the case of compact flares, the flaring arch diverges from a pivot point (rigid rotation), while in the case of double ribbon flares the flaring arches are distributed to either side of the polarity reversal line.

Solar flares can be subdivided into two categories according to their morphological structure : compact flares and double ribbon flares. Moreover, we have shown (Mouradian et al., 1983) that the flaring arch is the basic element of all flares.

FLARING ARCH

The flaring arch is a magnetic structure existing prior to the flare, and which suddenly becomes emissive in Hα, EUV and X. A flaring arch develops to either side of a magnetic field reversal line. The arch is asymmetrical, with one of its feet - the main one - being the point from which the flare propagates. An example of a flaring arch observed in X-rays by Skylab is given in Eddy (1979).

Figure 1



https://doi.org/10.1017/S0252921100154223 Published online by Cambridge University Press

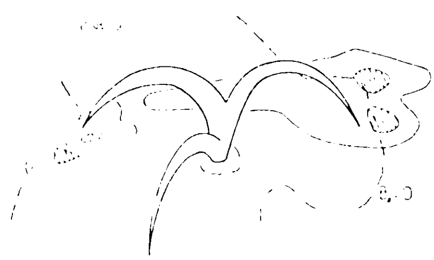
Another flare element is the surging arch, which is a magnetic structure ejected shortly before or during the flare. The simplest form of a flare is a structure with a single flaring arch, sometimes accompanied by a surging arch. This simple flare is called an "elementary eruptive phenomenon" (EEP) and is diagrammed in figure 1 (Flare of 1980, Sept. 6, at 13:00 UT).

COMPACT FLARES

Compact flares are formed by flaring arches that diverge from a pivot point.

In most cases, flares comprise a certain number of flaring arches (EEP), all of which have their main foot in a parasitic polarity. The parasitic polarity itself is a new magnetic flux that has appeared in the Active Center in the place of a region of rigid rotation called a "pivot point". Starting in 1984, pivot points have been detected and related with the eruptivity of the Active Center (Soru-Escaut et al., 1986). The association of pivot points with the magnetic flux and the parasitic polarities was made in Martres et al. (1986) and Mouradian et al. (1987). In figure 2, we give the scheme of a multiple-arch flare (1980, Oct.19. at 09:00 UT) that starts from

Figure 2



the parasitic polarity (pivot point) as the HXIS observations (courtesy of G. Simnett) reveal it to us (Mouradian et al., 1988, Simnett et al, 1988). This flare is the second of a series of three occuring in the space of one hour. The three flares satisfy the homology criterion defined by Martres et al., (1984), i.e. several successive flares in the same area having at least one structure in common. This homology criterion is explained by the fact that the main foot of the flares is always the same (the parasitic polarity) while the place where the arches loop back (secondary feet) may change. The pivot point is therefore the point of departure for the flare and remains fixed both during a given flare and from one flare to the next.

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DOUBLE RIBBON FLARES

On September 4, 1982, the RA 18549 (HALE) / USAG Region 3885 3886 produced a compact flare at about 00:30 UT and a double ribbon flare at about 02:00 UT, visible on the Meudon spectroheliogram at 06:52 UT (figure 3).

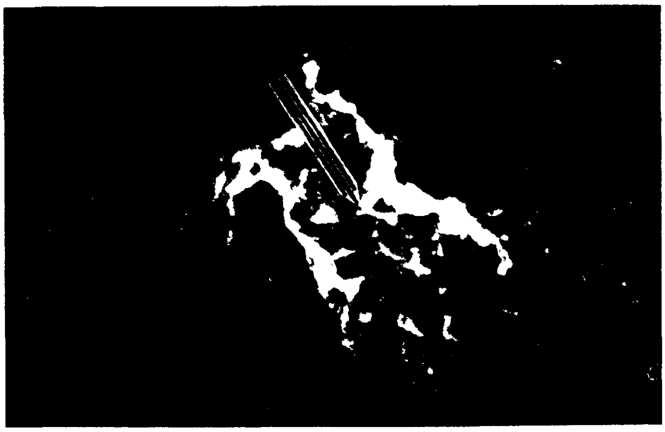

Figure 3

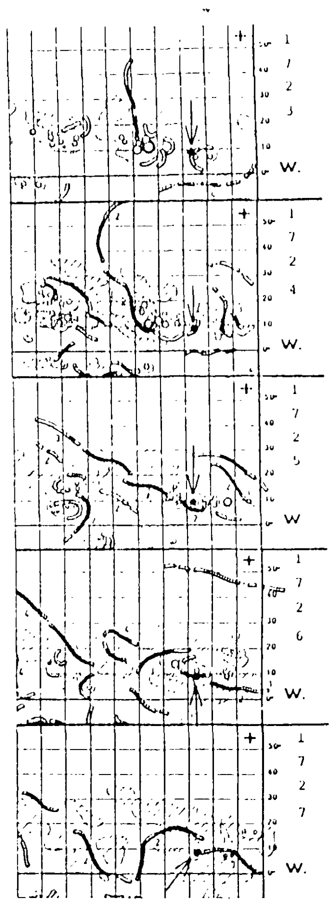

Figure 4

The evolution of these flares is given by Morishita (1987). The pivot point for the two flares formed during rotations 1723 to 1726 and persisted into rotation 1727 (figure 4). This figure, established with the Meudon Synoptic Charts, follows a given longitude through different rotations. It can be seen that successive filaments cross each other at the same heliographic coordinates as those of the pivot point (arrows), during five rotations. Its presence indicates the existence of a rigid rotation. The point is also the point of departure of the two flares. During the double ribbon flare, the two structures diverge from the two sides of the filament but the ribbon to the north remains "attached" to the pivot point (arrow in figure 3).
Another double ribbon flare is the one of June 6, 1982, at 16:29, with which we can study the flaring arch system. We see in figure 5 that the points of

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departure (figure 5a), which are the main feet, are located on the two sides of the polarity reversal line, and touch each other on the opposite side as they evolve (figure 5b). The polarity reversal line is located at the same point as a filament present

C

Figure 5

two rotations before (Soru-Escaut et al., 1985), which shows the existence of a rigid rotation. In figure 5c, we give the scheme of the flaring arch system.

All of the examples given here have in common the fact that the pivot point remains fixed during the flare and becomes one with its point of departure.

The flare scenarios described above are valid only for those cases where there is no magnetic reconnection. In the presence of reconnections, the flaring arch identity is destroyed.

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