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Filament Activity in a Quiet Region Flare

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Abstract. We have taken the case of a circular Hα filament observed on May 9, 1979 erupting into a double-ribbon flare associated with a non-spot region. The plage motions are responsible for the filament reorientation and, here as a special case, wherein the filament attains a clear circular shape before the onset of a flare. We conclude that the change in the orientation of the Hα filament marks the instability giving rise to the flare.

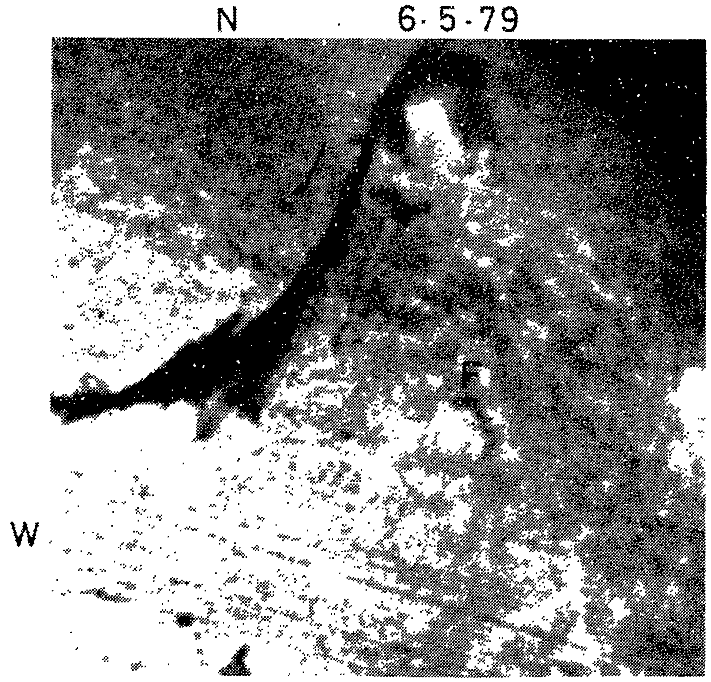
Key words: Spectroheliograms—spotless flare—Hα filament—plages

1. Introduction

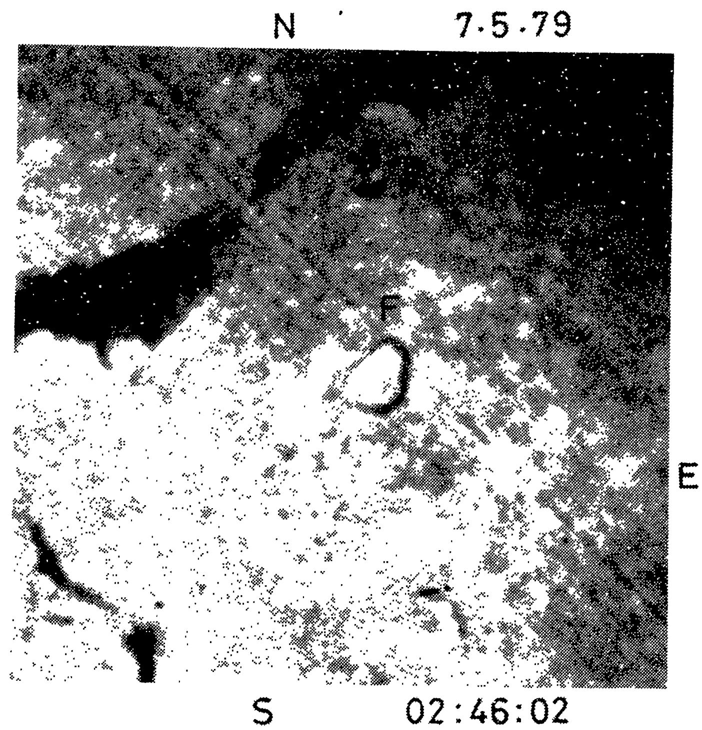
Solar flares occurring in quiet regions are interesting and exceptional events. Generally the spotless flares follow the activation and disappearance of dark Hα filaments (Moore & LaBonte 1980). Flares normally occur in regions which show fast changes in magnetic field structure. The complexity of the magnetic field gives rise to a non-potential state bringing in shear to the field lines. The surplus energy released during a flare is derived out of the magnetic energy stored in twisted or sheared magnetic loops (Martens & Kuin 1989). Hagyard *et al* (1984) observed that the magnetic field in the area of flare activity exhibited a much larger degree of shear than in the non-active areas of the region. We report here the analysis of a Hα filament activation in a non-spot region attaining a circular/loop shape before the onset of a flare. The twist observed in the filament indicates the non-potentiality and we believe that the plage motions set the beginning of this instability resulting in a ribbon type flare.

2. Observational data

The advent of vector magnetograms have given a better understanding into the relationship between flares and magnetic fields. Even then much information is still based on sunspots and plage observations. To identify the apparent motions in the solar atmosphere which outline the storage of magnetic energy departing from a potential field for the flare onset, we have studied the Hα and CaII K pictures taken at the Kodaikanal Observatory from 6 to 9 May, 1979. Whitelight photoheliogram of the sun of diameter 8″ is recorded everyday at Kodaikanal using a 6″ refractor. Spectroheliograms in Hα and also in CaII K are taken daily using a Littrow mount with a solar image diameter of 60 mm. The evolution of flare and Hα filaments are given in Fig. 1. Their corresponding CaII K spectroheliograms are reproduced in Fig. 2



(i)



(ii)

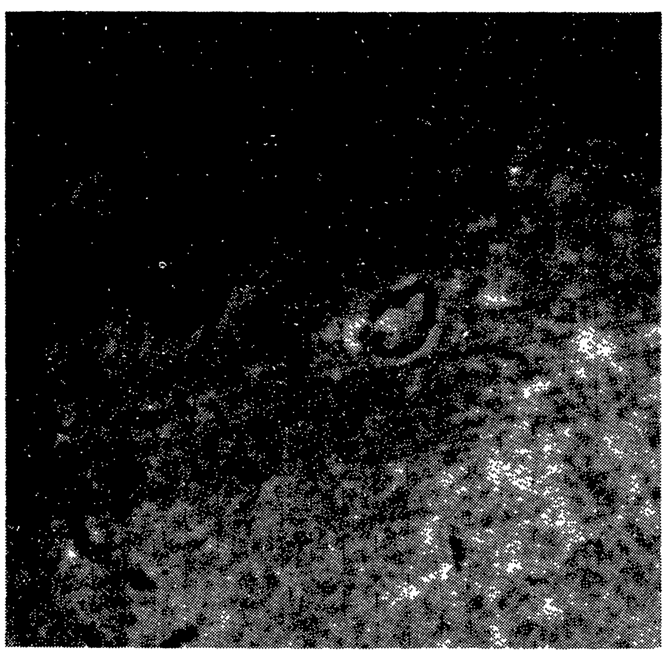
8·5·79 N

W

02:19:04 S

(iii)

9·5·79 N



E

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(iv)

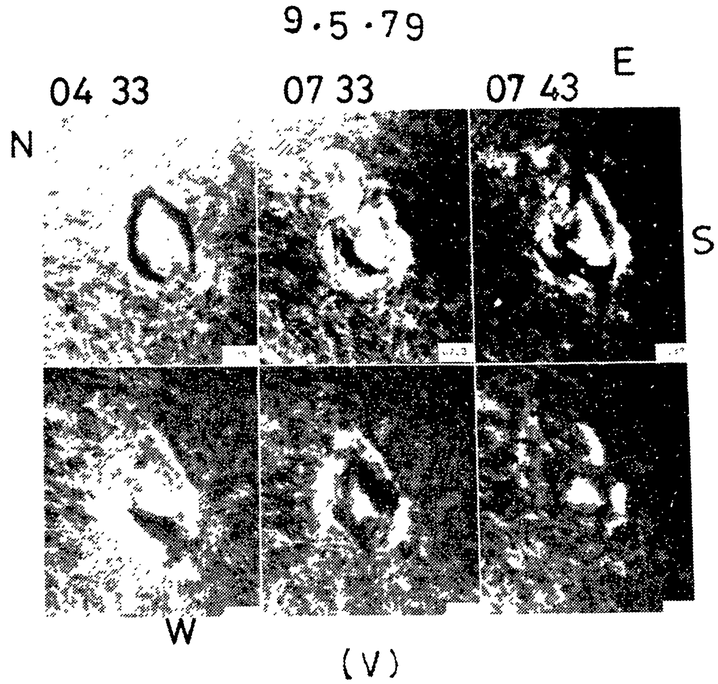


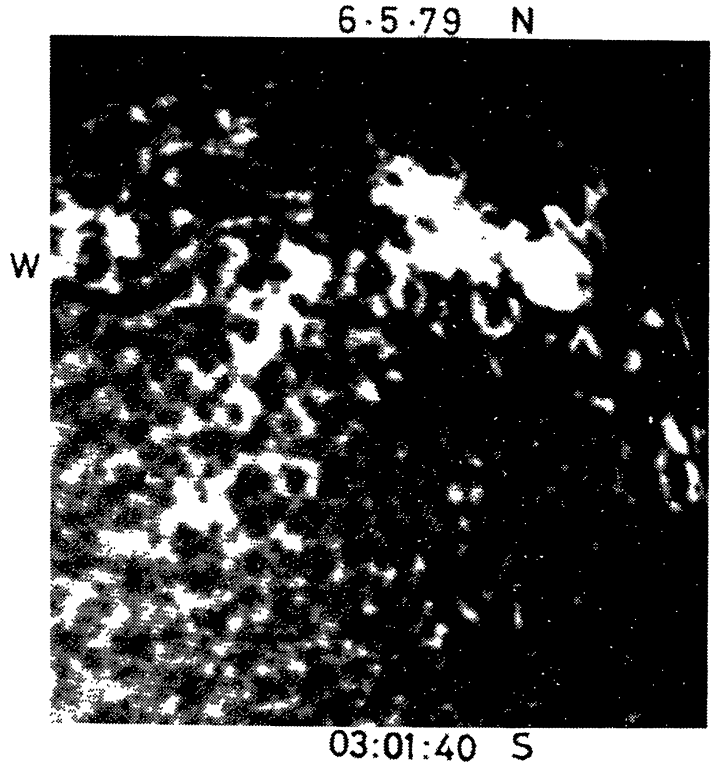
Figure 1 (i–v). Hα spectroheliograms from 6 to 9 May, 1979 showing the evolution of the filament giving rise to a flare.

and the whitelight photoheliogram of the flare day 9 May, 1979 is shown in Fig. 3. The following data reduction procedure to measure the angle "γ" which represents the filament activity is adopted. We have enlarged the Hα spectroheliogram image and projected it on to the photographic print of its CaII K spectroheliogram mate and aligned them for a perfect match using pole markings. We then sketched the filament in the CaII K spectroheliogram print as shown in Fig. 4. The angle between the Hα filament and an axis which is orthogonal to the line joining the centres of gravity of the plages P1 and P2 and the point of intersection of the Hα filament is defined as "γ".

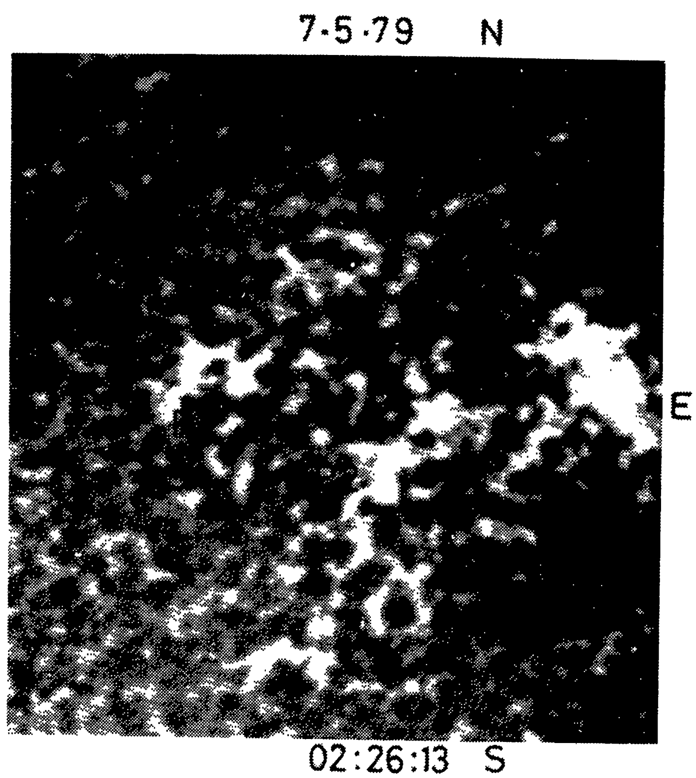
3. Results and discussion

Generally the flares originate closer to the line of zero longitudinal field, dividing the magnetic polarities. The zero line of magnetic field is identical with the position of dark Hα filament (Švestka 1976). The changes in the magnetic field structure due to magnetic shear may change the orientation of Hα filament. Here we have taken the case of a spotless flare associated with plages. The plage corridors or dark lanes which delineate the magnetic neutral line show the opposite polarity plages (Gibson 1973). The centre of gravity of these opposite polarity plage regions are taken as reference for studying the variation of Hα filament direction ("γ") from one day to the other. This may represent a method of finding out the value of shear in the case of spotless flares.

On May 6, 1979 a filament F (Fig. 1) appeared at N22 E23 in between the plages marked as P1 and P2 (Fig. 2). It is interesting to note the change in the orientation of the Hα filament on the next day. The area of the plage P2 has grown (frame ii,



(i)



(ii)

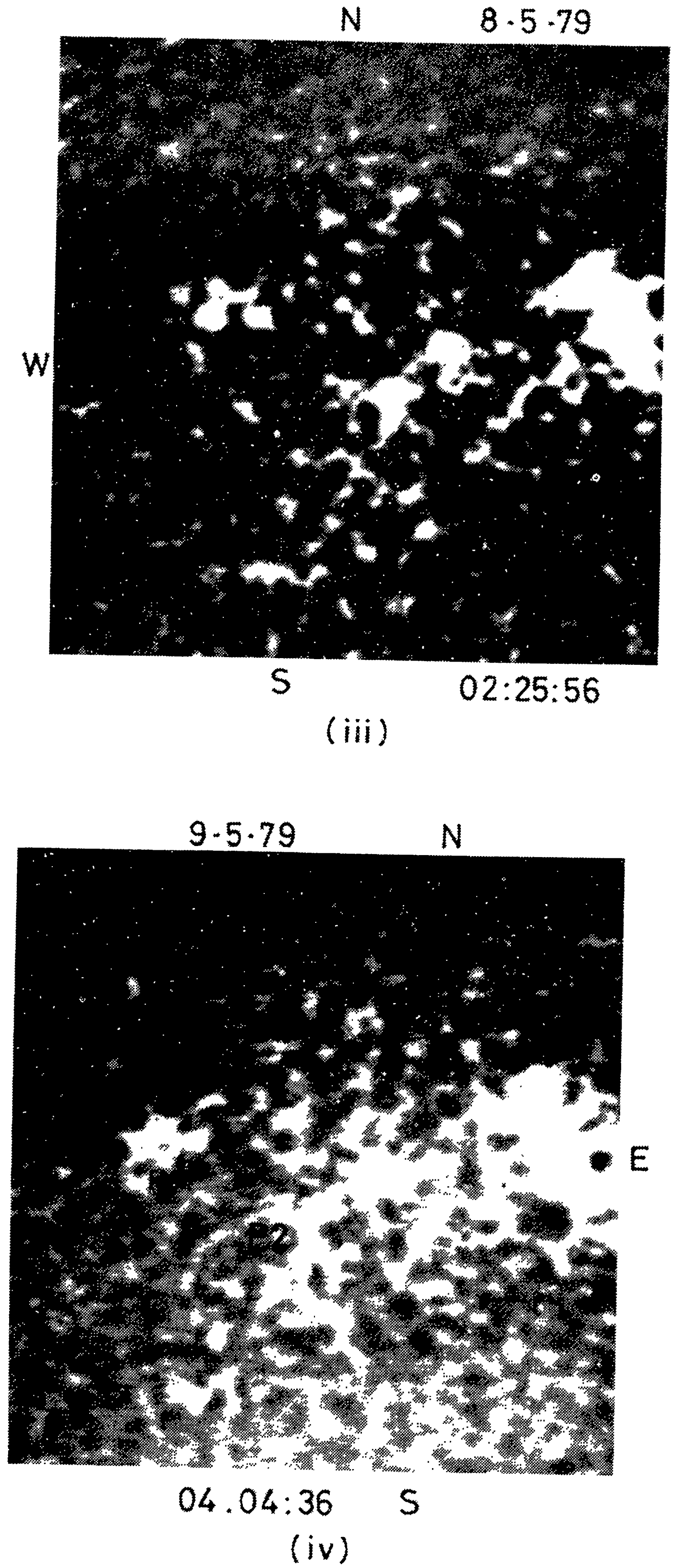


Figure 2 (i–iv). CaII K spectroheliograms of the corresponding region from 6 to 9 May, 1979.

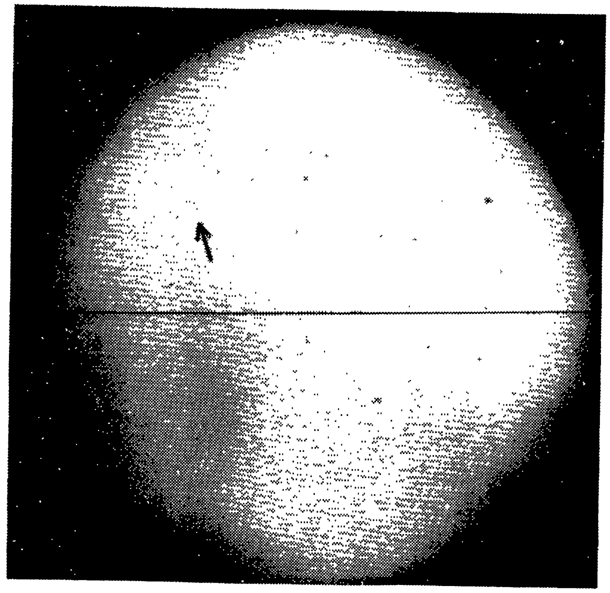


Figure 3. Whitelight photoheliogram of the flare day 9 May, 1979. The arrow mark indicates the flare region.

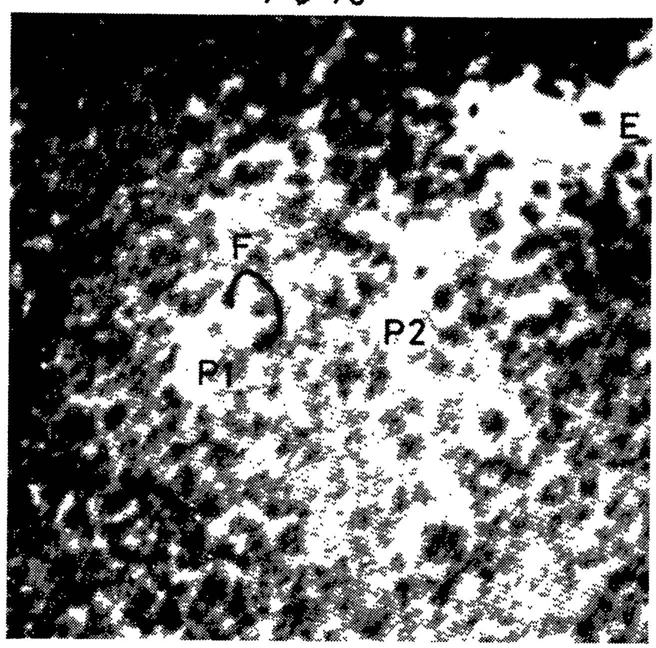


Figure 4. Hα filament superposed on the CaII K spectroheliogram to measure "γ".

Fig. 2) and the filament looks to be anchored over the plage P1 attaining a semi-circular shape. The area of the plage P2 and the filament have further grown on 8–9 May, 1979. At 03:58 on May 9, 1979 the filament is at N22 W20 and the plage motions are visible compared to the previous day. This change in the plage orientation

Table 1. Change in the orientation of the Hα filament as a measure of flare activity.

No.	Date	"γ" in degree
1	May 6, 1979	87
2	May 7, 1979	60
3	May 8, 1979	8
4	May 9, 1979	2

contributed the filament to attain a remarkable circular shape and became untenable resulting in a flare. Large portions of the filament disrupted and the flare ribbons appeared at 7:33 UT. Dark loops joining the ribbon can also be seen. The filament material exhibited intense activity and finally the entire filament disappeared leaving its signature in the form of some faint emission patches. The flare sequence in Hα shown in frame V of Fig. 1 is reproduced from the Photographic Atlas of the Solar Chromosphere edited by A. Ambastha and A. Bhatnagar (credit goes to Udaipur Solar Observatory). The values of "γ" are given in Table 1. A look at Table 1 shows that initially the change in the orientation of the filament is small. However, variation in the value of "γ" from 7 to 8 May, 1979 becomes much more pronounced and the triggering of the flare had taken place on May 9, 1979. Based on the analysis of the angle "γ" on different days for this region, the following conclusions are drawn. "The changes in the filament direction is caused by the shear motions of plages. The larger variations in the value of "γ" alone are not sufficient conditions for the flare onset. The cumulative change in the filament direction coupled with the variations in the plage orientations on a specific day play an important role on the evolution of a spotless flare. It suggests that two oppositely directed fields in the form of plages are pushed together in a steady motion, as a result the lines of force reconnect in a neutral plane and trigger the flare.

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