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TWO RIBBON FLARE ON APRIL 3, 1980

Rajmal Jain
Udaipr Solar Observatory
11, Vidya Marg
Udaipur 313 001 India

Abstract

H_α observations of a two ribbon (TR) flare which were associated with exceptionally high microwave (MW) and hard X ray emissions are presented and discussed The good spatial and temporal resolution of the H_α data allow us to investigate the detailed flare structure and its variation during each phase of the event Strong MW emissions were found to be associated with the smallest flare but located in the inverted polarity region

1 Introduction

The two ribbon flares tend to occur primarily in magnetically complex active regions, where pattern of opposite magnetic polarity intermingle and mutually penetrate in a complicated way The complex groups also produce the most energetic flares giving rise to hard X rays and radio bursts (Svestka and Simon 1969, Kruger 1969, de Jager 1975, Jain 1983, Jain 1985) The locations of the hard X ray bursts coincide in position with H_α flare kernels (Hoyng et al 1983)

In the present paper a detailed description of the optical flare of importance 2B occurred on 1980 April 3 at 0650 UT in the Hale active region No 16740 (N29 W17) is presented The flare was associated with X rays and microwave bursts The time lapse H_α observations were made at 10s intervals from the Udaipur Solar Observatory, using the 150 mm aperture telescope, in conjunction with a 0 5 A passband Hale filter The solar seeing was between 2 and 3 arcsec

2. Observations and Analysis

Shown in Figure 1 are H_α filtergrams of the alctive region from 1st April through 3rd April, 1980 The broken and curvilinear long filament F appeared crossing the plage north south in the region, showed considerable activity throughout the period of observations from 0800 to 1235UT on 1st April, 1980 (Fig 1a,b,c,d) The filament material was ejected out in the north west direction The filament activity is obvious in off band sequence and shown in fig 1 b,c and d On 2nd April, filament motion at the north end, subflares and extension of plage were observed On 3rd April at 0325 UT only south west curved portion of the filament F was visible At this time the plage was not intense and extended but around 0430 UT the plage expanded and started to become brighter in the region east of the following spot f Around 0637 UT a flare of importance 1B occurred in the region and spread over the filament position Before this flare completely decayed, it again developed at 0650 UT to become a two ribbon flare of importance 2B and to reach peak intensity around 0710 UT The dark filament was visible until 0700 UT and thereafter it vanished As the ribbons were separating away from each other, the dark filament was seen to be reappearing A bright mass ejected around 0632 UT was observed to move initially with a velocity of about 60 kms, which increased to 330 kms at about 0639 UT During the flare activity, dark and bright surges were observed to eject out from the region towards the west of the spots

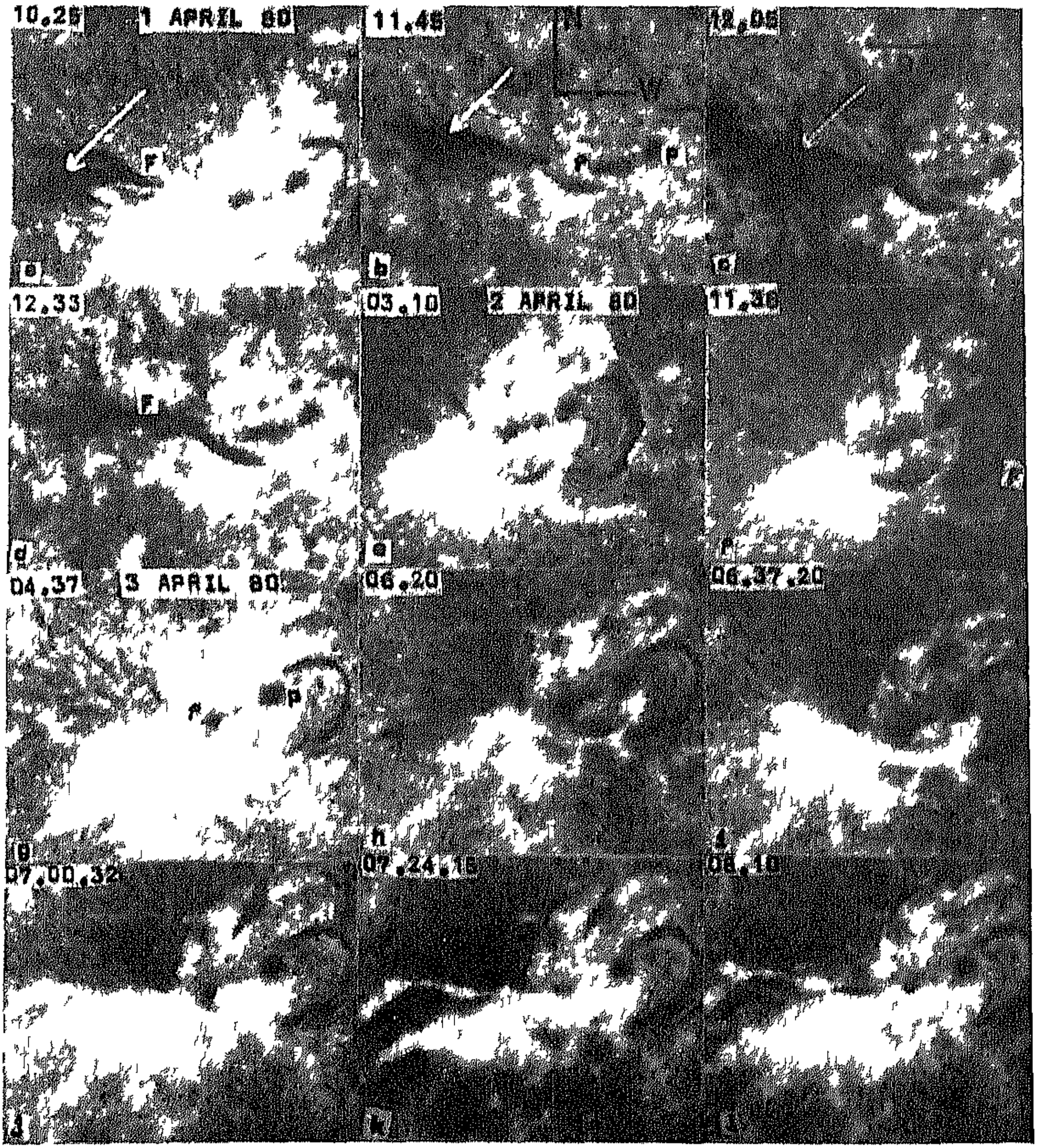

Fig. 1 H_α Filtergrams of the Hale active region no 16740 from 1st through 3rd April 1980 Note activity in the filament F

In Fig 2 we have shown H_α field topology before and after the flare It is interesting to note that before the flare occurrence no filament was observed intersecting the plage between preceding and following spots However as shown in Fig 2b, a clearcut thin dark filament was visible after the flare around 0722 UT This indicates the existence of an inverted polarity region The locations of flare kernels 5, 13 14 and 15 i e pair no 2 and flare kernels 18, 19 and 20 i e pair no 3 are very close to the newly formed filament This indicates lthat these pairs of flare kernels are the positions of strong magnetic field gradient

The spatial resolution on the film allows us to study the development of the flare kernels (pairs no 2 & 3) and flare ribbon (no 1) Shown in Fig 3 (bottom) is the growth of the flare kernels 1, 5, 13, 14, 15, 18 19 and 20, in terms of area in millionth of the solar disk with respect to the time During the first flare occurred at 0637 UT, the flare kernels 1 & 5 showed small growth around 0640 UT and after that they declined The major flare of importance 2B started around 0650 UT when the flare ribbon 1 showed huge growth This ribbon peaked at 070915 UT in H The flare kernels 13, 14 and 15 appeared around 0647 UT and joined with kernel 5 around 0655 UT Thus the area curve of kernel 5 after 0647 UT is actually an integrated area curve for kernels 5, 13, 14 and 15 i e pair no 2 This curve shows two peaks, at 065630 UT and at 0713 UT respectively The flare kernels 18, 19 and 20 i e pair no 3 identified around 0702 UT and joined together at 0707 UT showed its peak in the area curve at 071930 UT The growth and decay of flare kernels in pairs 2 and 3 were slow as inferred from Fig 3, however growth and decay of flare ribbon 1 was faster and it attained maximum area among several peaks

In Fig 3 (middle and top) we have shown microwave bursts at 6 1, 10 715 and 35 GHz, observed in association with the optical flare under study The different groups in the microwave burst are named as C, D and E which are in fact MW peaks coinciding in time and the H_α peaks of ribbon 1, pair no 2 and pair no 3 respectively

3 Discussion

The Hale active region no 16740 was complex in nature An inverted polarity region seen within the positive polarity of preceding and following spots The flare ribbon 1 occurred predominantly in negative polarity region but flare kernels forming pairs 2 and 3 occurred very close to the newly formed thin filament (i e) line of inversion and hence in the region of strong magnetic field gradient This is also a signature of interaction between previously existing and newly formed loops which generally give rise to a two ribbon flare This has been observed in this case too

The MW peaks C, D and E corresponding in time with the H peaks of ribbon 1 and pairs 2 and 3 respectively, obviously emphasize that the strongest MW enhancement (E) was given rise by pair no 3 (composed of flare kernels 18, 19 and 20) The low enhanced peak was perhaps associated with the largest H_α area peak, i e , ribbon 1 This gives an idea that it is the magnetic field gradient which is important to give rise to strong emission on centimeter and millimeter wavelengths

Acknowledgements

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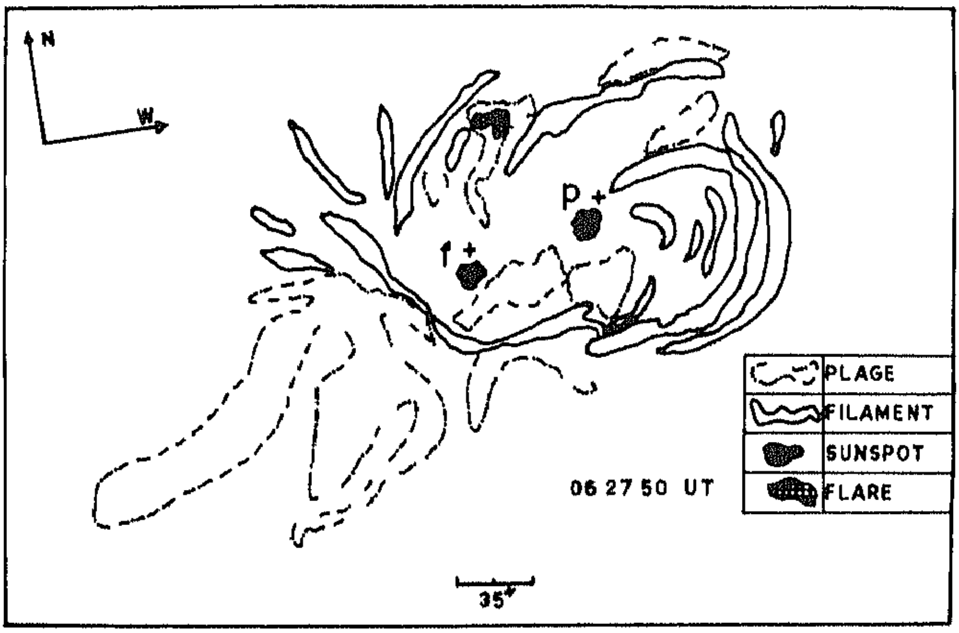

Fig. 2a Line drawing of the chromospheric field topology before the flare occurrence

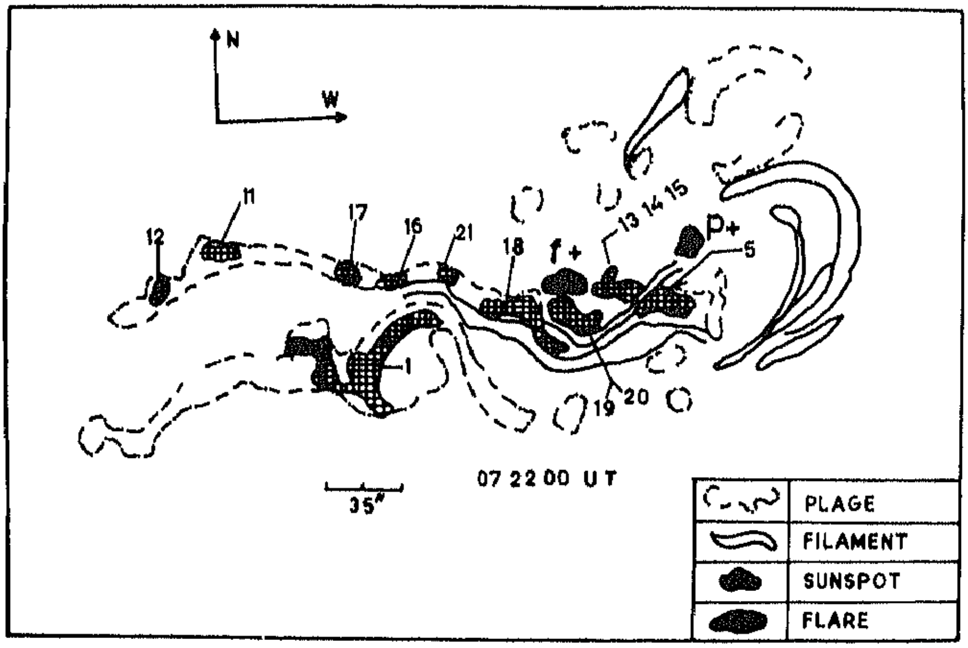

Fig. 2b Line drawing of the chromospheric field topology after the flare decay Note the thin newly formed filament across the plage between preceding and following spots

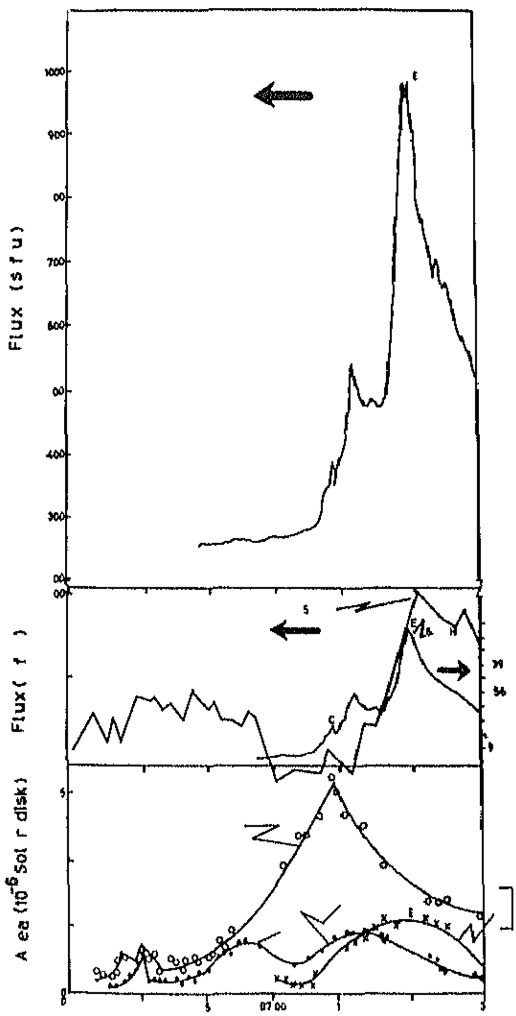

Fig.3 (Bottom) Growth of the flare kernels in terms of area in millionth of the solar disk with progress in time
(Middle) Microwave flux enhancement at 6 l and 35 GHz in association to the above flare
(Top) Microwave flux enhancement at 10,715 GHz in association to the above flare

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