COLLABORATION WITH OPTICAL OBSERVATIONS

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ABSTRACT:

Which type of data we can bring out from our optical instruments and how the optical observations can contribute in the collaboration of flare study with the NOBEYAMA NEW RADIOHELIOGRPH are discussed in this talk by demonstrating the high resolution observations of the October 12 1981 flare.

The October 12 1981 flare is one of the biggest and one of the well-observed flare in the last solar maximum. The high resolution Hα observations were obtained with the DOMELESS SOLAR TELESCOPE at Hida observatory, Kyoto University, and the results of the detailed photometry of them can be reffered to KITAHARA AND KUROKAWA (Solar Physics 125, 321(1990)).

Since the most important task of the optical observations may be the study of the flare build-up processes, I will concentrate into the build-up process of the October 12 1981 flare. By examining the active region evolution and the flare-development morphology, I will show which type of magnetic fields had been formed in the flare region before the the October 12 1981 flare in the following.

HIGH-RESOLUTION OBSERVATIONS OF Hα FLARE REGIONS*

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(Received 20 August, 1988)

Abstract. This paper gives a review of the recent high-resolution Hα observations of solar flares and flare-productive active regions. From studies of the morphological and evolutional features of Hα flare emitting regions, two types of two-ribbon flares, which are termed *separating two-ribbon flare* and *confined two-ribbon flare*, are discussed. The former is characterized by conspicuous separating motions or expanding motions of the Hα two ribbons, whereas the latter shows only a short range of or no separating motions of the two ribbons. The explosive compact flares, which occur in some compact newly-emerging flux regions, are also discussed.

Attention is paid to the successive and impulsive brightenings of Hα flare points which form the Hα flare kernels and the front lines of Hα two ribbons at the impulsive phases of flares. Temporal relationships between Hα line intensities or profiles and hard X-ray or microwave emissions are discussed to discriminate the energy transport mechanisms in the flare loops.

Hα monochromatic image of high spatial resolution, at the present time, is the most sensitive detector for finding the first appearance of newly-emerging magnetic flux region and the developing features of sheared configuration of magnetic field, both of which are the key factors in flare energy build-up processes. It is suggested that the successive emergence of a twisted magnetic flux rope might be essential for the production of a major flare..

1. Introduction

The advantages of optical observations in the solar flare research are summarized as follows:

(1) The high-spatial resolution of 1″ ~ 0.2″, which is at least necessary for studying the fine structures of magnetic loops essential to flare processes, can be achieved. It is about one order higher than in other wave lengths at the present status.

(2) The evolutional changes of magnetic field configuration of the flare region can be examined from the morphological changes of the fine structures of sunspots, Hα fibrils and Hα filaments.

(3) The magnetic field vector of the photosphere can be quantitatively measured.

(4) The growth or shift of Hα flare emitting regions, which are the footpoints of the flare loops, can be traced in detail. It helps us to study the distribution and evolution of flare loops together with X-ray and microwave data.

(5) Evolutional changes of thermodynamic structures in the chromosphere and the photosphere heated by high-energy injection from the corona can be studied. This enables us to discriminate the energy transport mechanisms in the flare loop.

The very high temperature material where the initial energy release of flares occurs is, however, invisible in the optical range. Therefore, X-ray and microwave observations are simultaneously needed to make the optical data efficiently work. Recent progresses in X-ray and microwave observations have still increased the importance of high-resolution optical observations.

* Contributions from the Kwasan and Hida Observatories, Kyoto University, No. 292.

Space Science Reviews 51 (1989) 49–84.

Collaboration with Optical Observations

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■ Flare Build-up Process in the Oct. 12, 1981 Flare Region:

"Which type of magnetic field configuration is formed before the flare?"

Active Region Evolution

Successive Emergence of differently-oriented magnetic flux loops.

⇓

Height-Dependent Sheared Configuration of Magnetic Field

Flare Development Morphology

(1) Precursoring Brightenings — Earliest Phase

around { · the strongly-sheared penumbra · the emerging flux region · the emerging sheared filaments }

Low-lying Loops

(2) Successive and Impulsive Brightenings of many flare points — Impulsive Phase

Formation of two or multiple flare ribbons along the neutral line

Middle-height Loops

(3) Expanding-Ribbon Brightenings — Explosive and Main Phase

the later, the higher loops flare-up.

High and Outer Loops

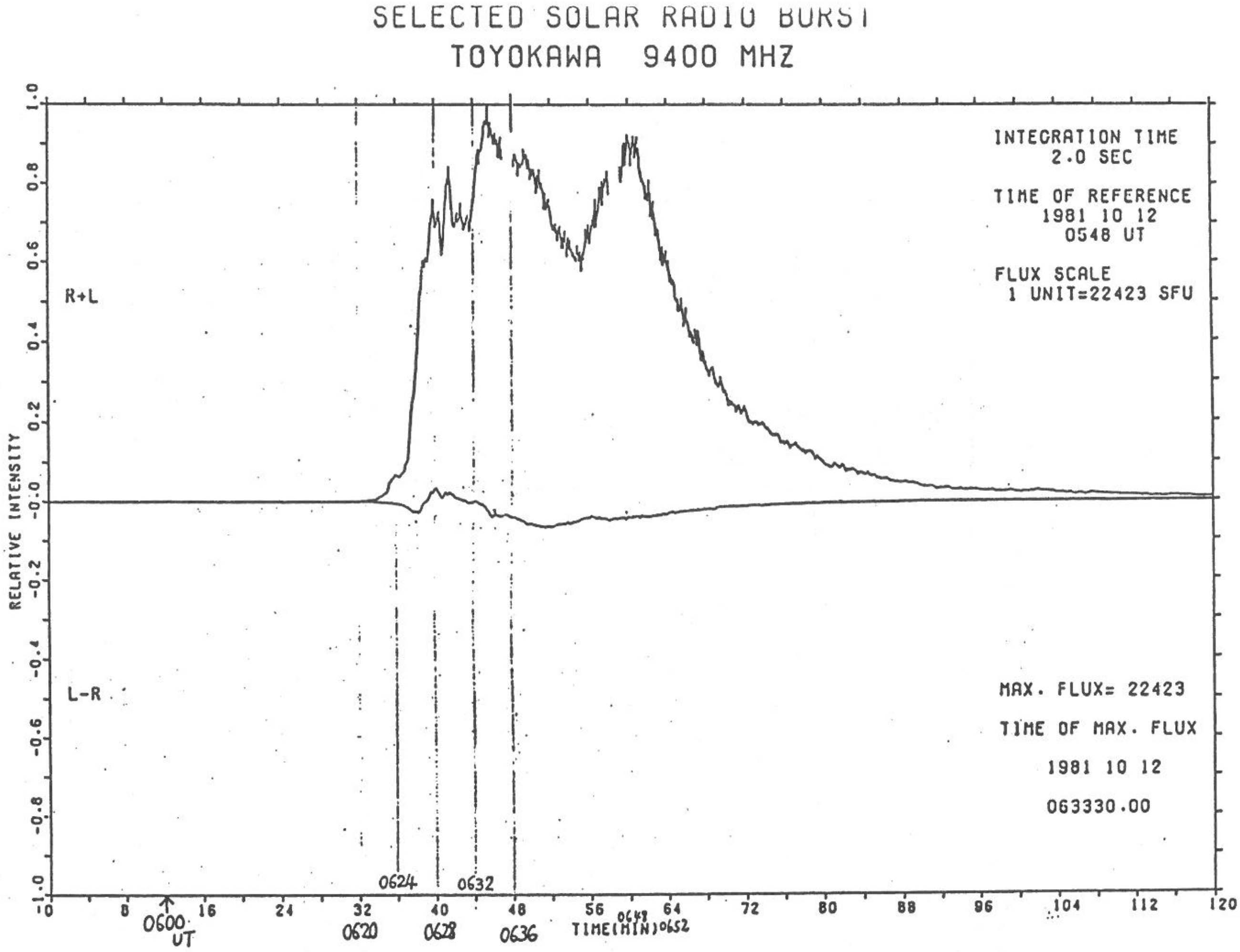
⇓

consistent with the Height-Dependent Sheared Configuration

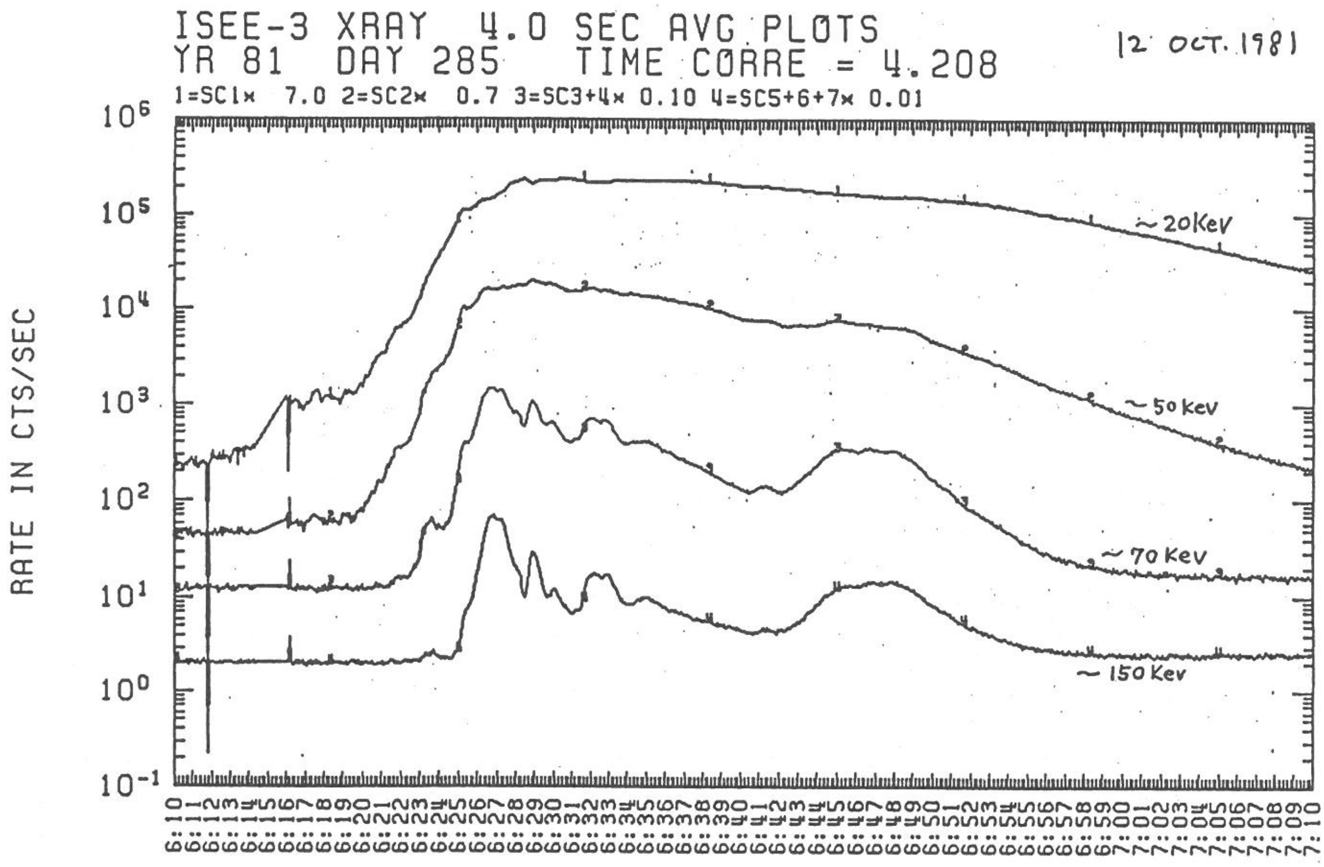
⇑

(4) Postflare Loops — Postmaximum Phase

Change of Orientation of flare loops



SELECTED SOLAR RADIO BURST
TOYOKAWA 9400 MHZ
INTEGRATION TIME 2.0 SEC
TIME OF REFERENCE 1981 10 12 0548 UT
FLUX SCALE 1 UNIT=22423 SFU
MAX. FLUX= 22423
TIME OF MAX. FLUX
1981 10 12
063330.00
R+L
L-R
RELATIVE INTENSITY
TIME(MIN)
0600 UT
0620
0624
0628
0632
0636
0648
0652



ISEE-3 XRAY 4.0 SEC AVG PLOTS
YR 81 DAY 285 TIME CORRE = 4.208
12 OCT. 1981
1=SC1× 7.0 2=SC2× 0.7 3=SC3+4× 0.10 4=SC5+6+7× 0.01
RATE IN CTS/SEC
~20KeV
~50 keV
~70 KeV
~150 KeV

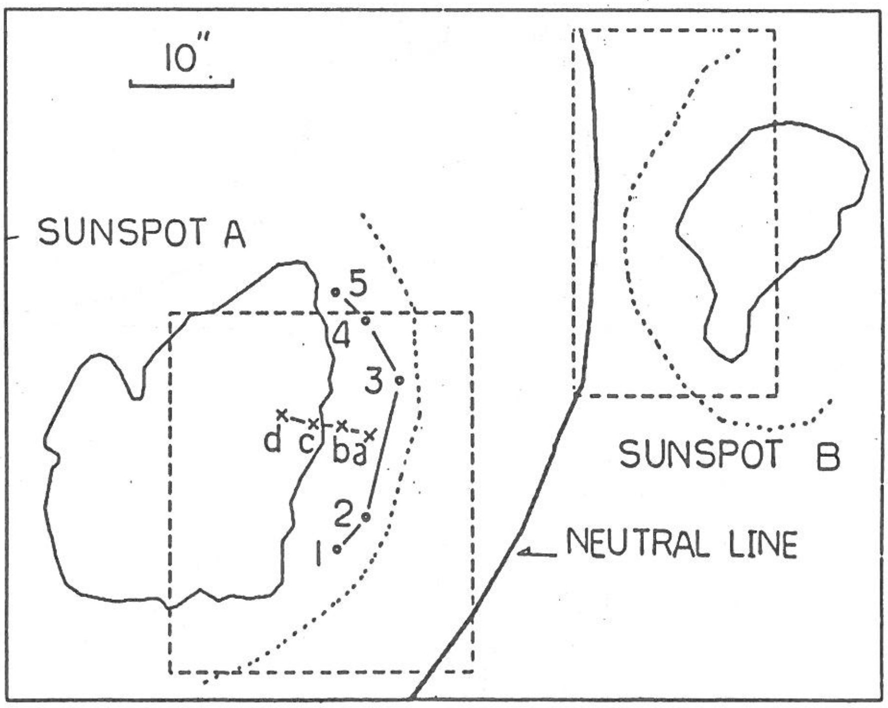


Fig. 2. A sketch of the flare region. The outer boundaries of the sunspot umbrae and penumbrae are indicated by full and dotted lines, respectively. Broken lines show the areas scanned by the two-dimensional microdensitometer. The path of the progressive brightenings at the first stage of the impulsive phase is shown by the line 1–2–3–4–5 in sunspot *A*. The line a–b–c–d shows the direction of the Hα-ribbon expansion at the second stage of the impulsive phase.

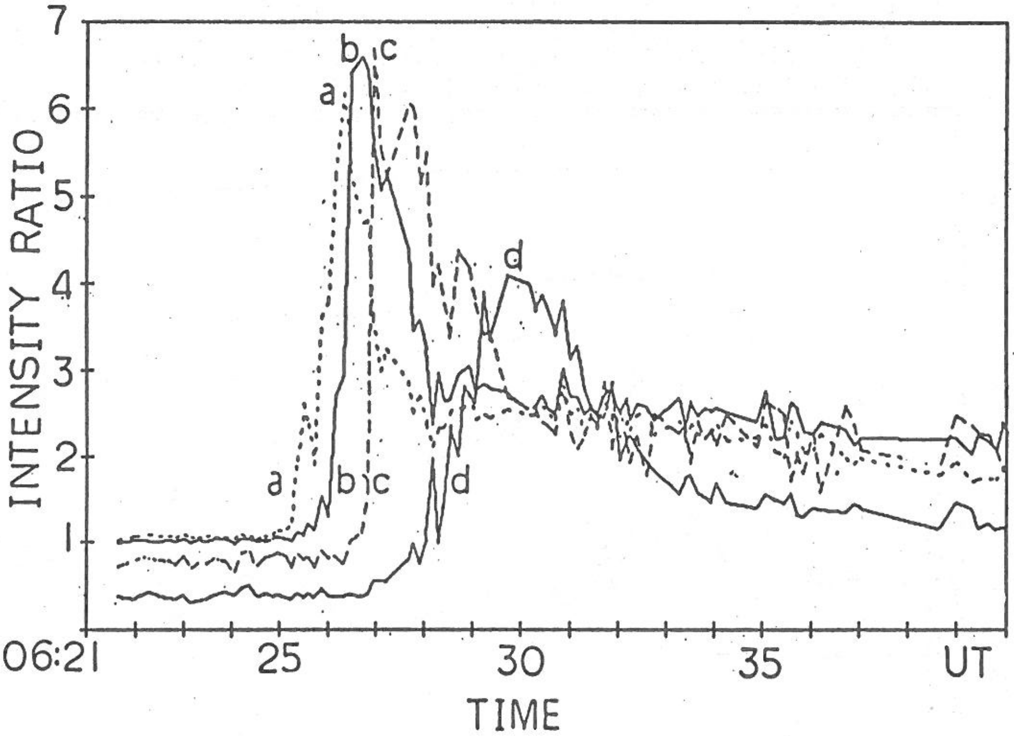
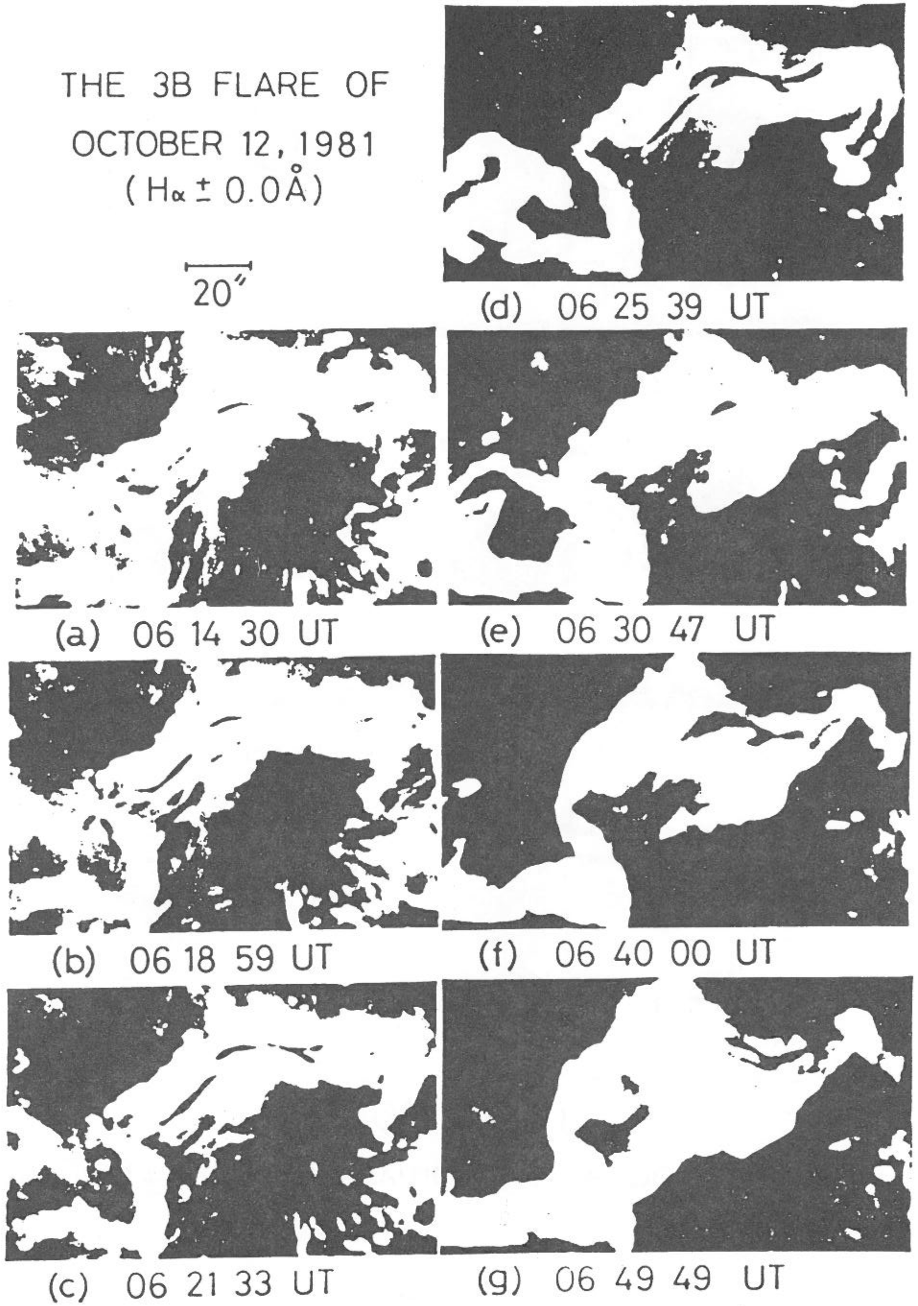


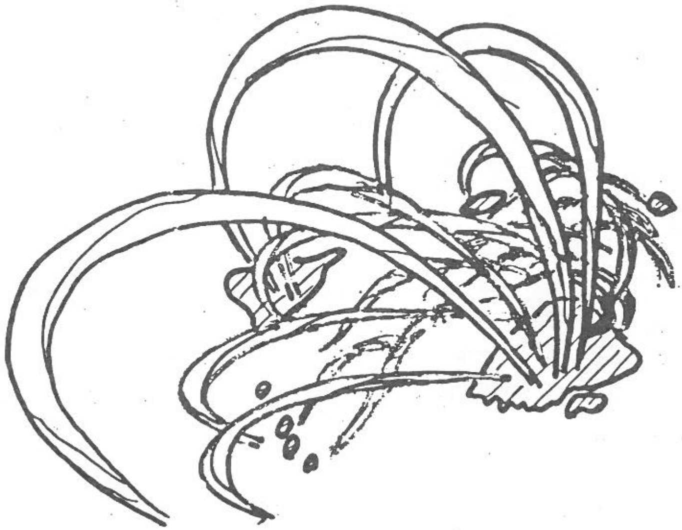
Fig. 3. Hα light curves of the points a, b, c, and d shown by crosses in Figure 2. The ordinate gives intensity ratios or intensities of flare points relative to the mean intensity of a quiet region near the flare. The abrupt and successive rising-up of light curves corresponds to the rapid expansion of the Hα ribbon.

THE 3B FLARE OF
OCTOBER 12, 1981
(Hα ± 0.0Å)



Preflare Configuration of Magnetic Field in the Oct. 12 1981 Flare Region

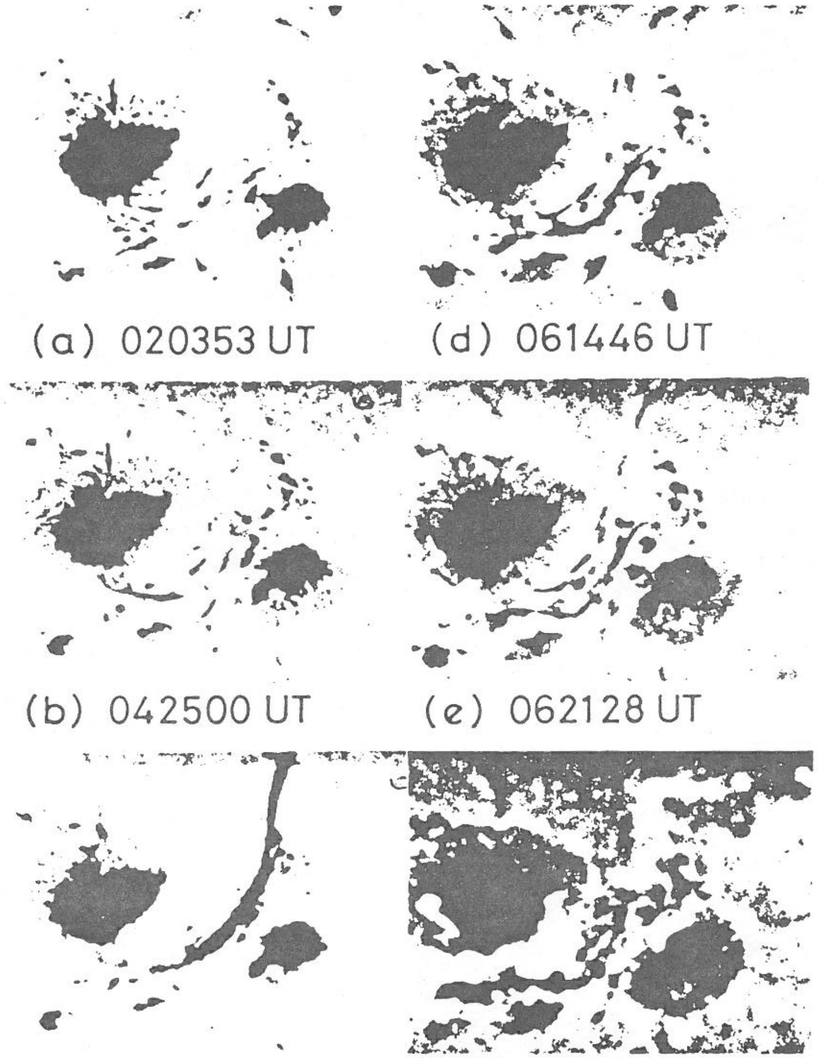
Oct. 11



Oct. 12

Emerging Filament Activities Before the 3B Flare

(12 Oct. 1981)



(a) 020353 UT (d) 061446 UT

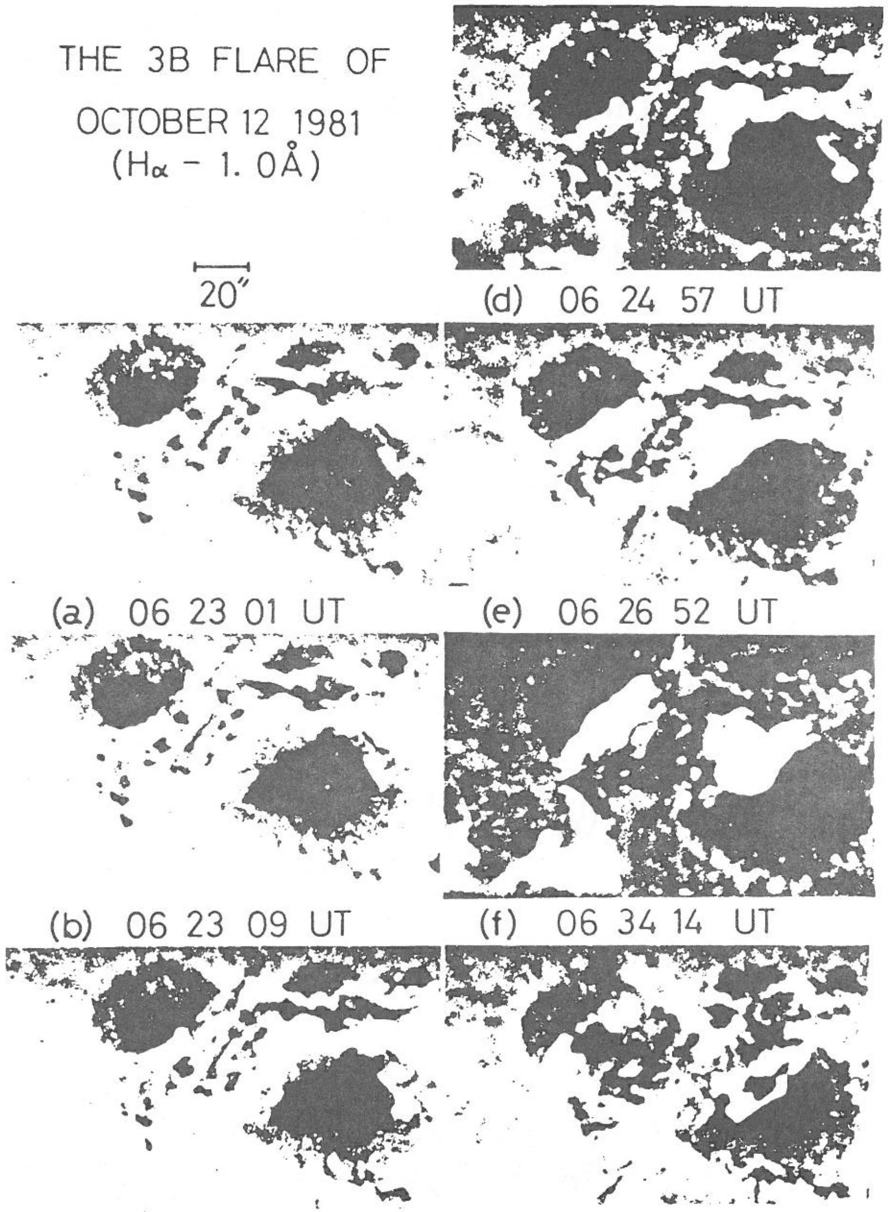
(b) 042500 UT (e) 062128 UT

(c) 050806 UT (f) 062457 UT

THE 3B FLARE OF

OCTOBER 12 1981

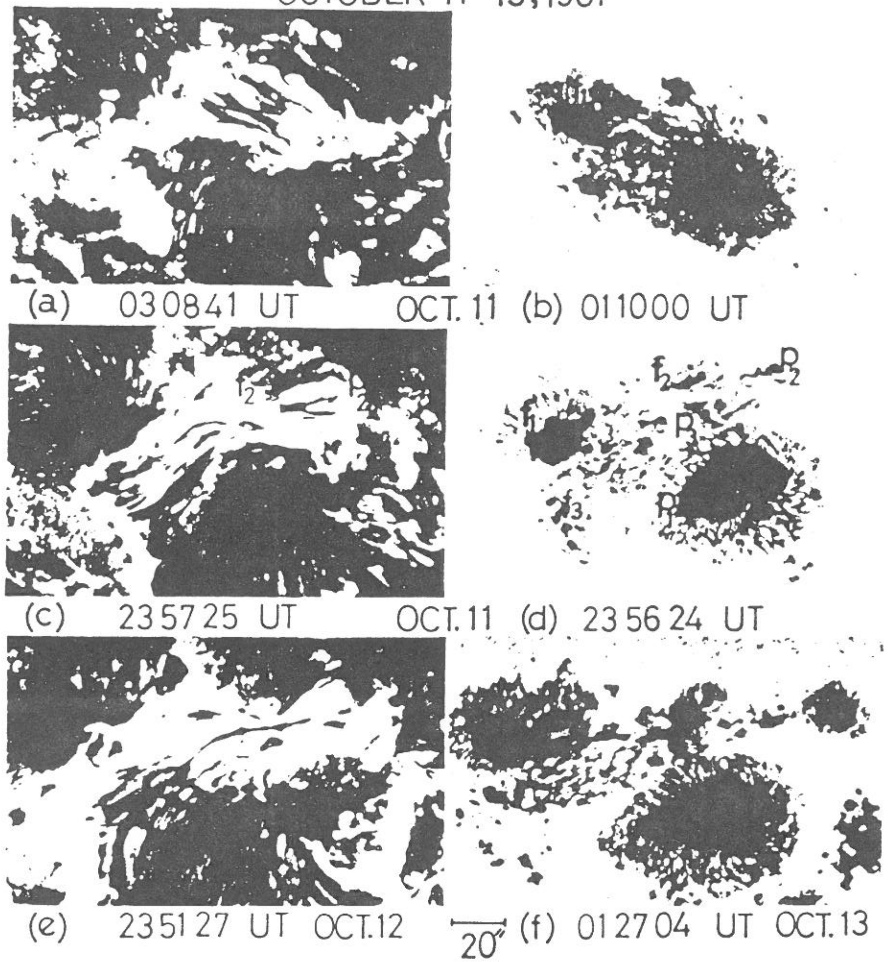
(Hα − 1. 0Å)



(a) 06 23 01 UT (b) 06 23 09 UT (c) 06 24 31 UT

(d) 06 24 57 UT (e) 06 26 52 UT (f) 06 34 14 UT (g) 06 52 52 UT

DEVELOPMENT OF MAGNETIC SHEAR
OCTOBER 11-13, 1981



Emerging Filament Activities Before the 3B Flare
(12 Oct. 1981)