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Solar flare of 1982 April 14

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Abstract. We have obtained a good time sequence of spectroheliograms and spatial sequence spectra in the K-line of Ca II using the Kodaikanal tower telescope. We have derived the two dimensional pattern of the mass motions of the plasma associated with the flare at this level in the solar atmosphere. We find that significant mass motions are practically confined to the two ribbons that developed soon after the flaring event.

Key words : Solar flare—Ca K spectra

The flare observed on 1982 April 14 occurred over the active region 27° S and 1° W, associated with the Kodaikanal sunspot No. 17815. The flare had an area of 1071 millionths of the visible disc. It was a two-ribbon flare of importance 2B and was observed for a duration of 52^m, starting from 0248 UT. We have the following observations on this flare :

(i) Full disc K_{232} spectroheliogram at 0237 UT.
(ii) Specroheliograms in K_{232} in rapid sequence, covering the region of the flare on the solar disc from 0304 to 0314 UT.
(iii) Visual observations of the flare in H_α through the spectohelioscope.
(iv) Spatial sequence of spectra in the K line, covering the flare region from 0320 to 0334 UT.

For the observations (i), (ii) and (iii), a solar image of 56 mm diameter giving a resolution of 33 arcsec mm^{-1} was used whereas for (iv), the 340 mm solar image and the main spectrograph of the Kodaikanal tower telescope were used. The spectrograph was used in the first order with a dispersion of nearly 1 Å mm^{-1}, the scale of the image being 5.5 arcsec mm^{-1}.

The visual observations which commenced at 0248 UT clearly showed that a flare was in progress in the region specified above. Thee first K_{232} specroheliogram obtained at 0237 UT showed an early phase of the flare. The H_α spectroheliogram taken at 0253 showed the two-ribbon structure as seen in figure 1. The K_{232} sequence which followed this shows the development of the two ribbons of the flare. The observed flare development in K is shown in figure 2a.

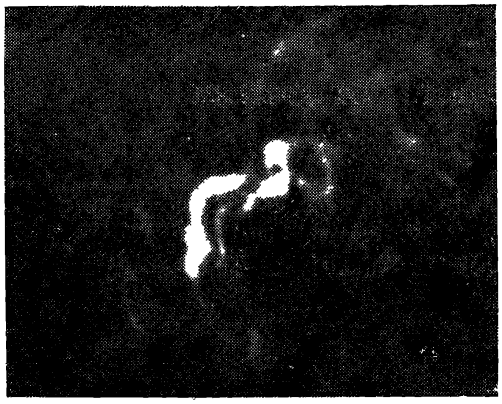

Figure 1. The flare as seen in H_α spectroheliogram taken at 0253 UT.

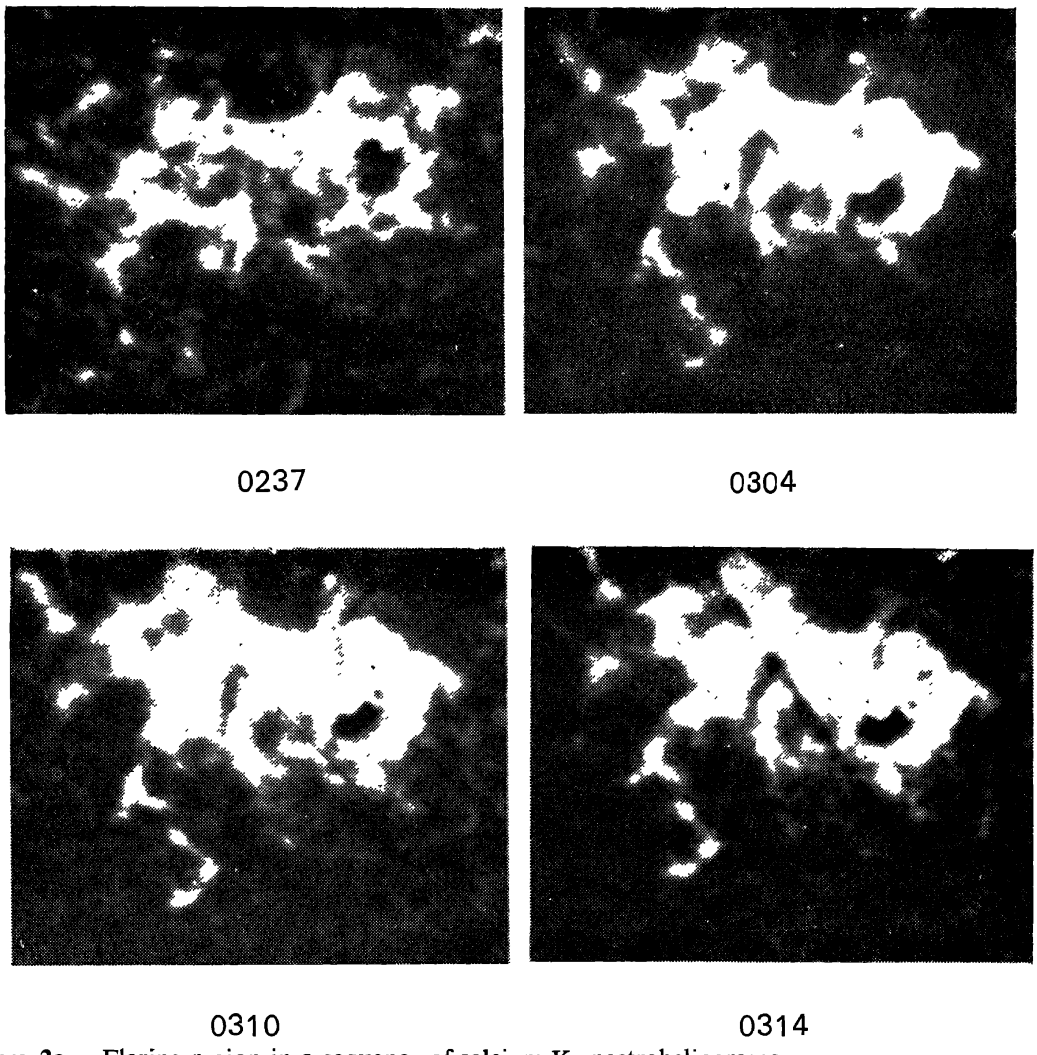

Figure 2a. Flaring region in a sequence of calcium K spectroheliograms.

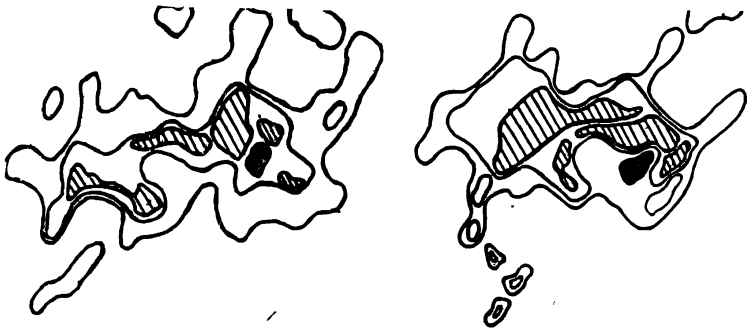

Figure 2b. Isodensity (brightness) contours for the calcium plage associated with the flare. Spot umbra is shown dark and the innermost contours are shaded.

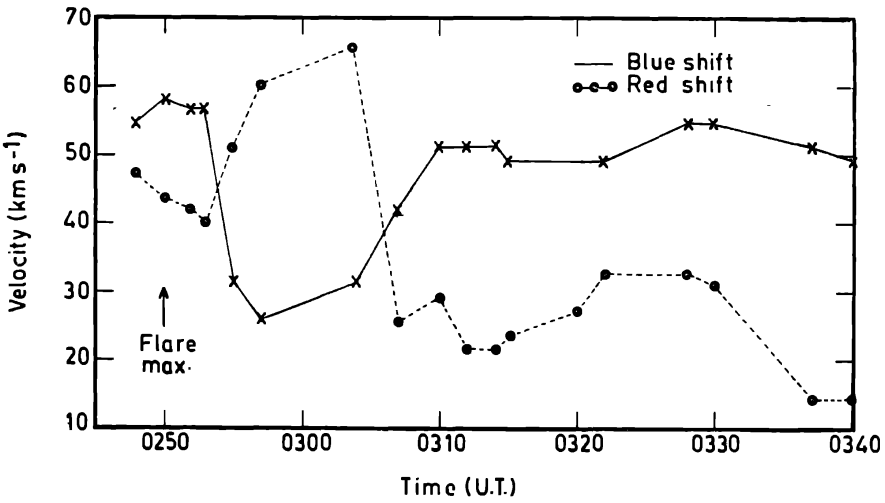

Figure 3. Velocities of mass motions as seen in H_α.

The continuous monitoring by visual observations in H_α provided the velocities of the mass motions present in the flaring region. The redward velocities reached a maximum of 65 km s^{-1}. The measures of velocities with progress of time are shown in figure 3.

The spatial sequence of spectra was obtained commencing from 0320 UT, locating the entrance slit of the spectrograph on the active region and by stepping up the image every 10 arcsec. Each time the slit position with respect to the active region was transferred to a drawing through a plumbline.

We scanned the spectra with a densitometer and converted these into relative intensities via the calibration. From these, the velocity shifts of the K-line were derived with reference to a neighbouring Fe I line. In figure 4, the spatial distribution of the velocity vectors are represented on a drawing of the active region. It can be seen that the mass motions are confined to the two ribbons, and the velocities are in the range of 2 to 5 km s^{-1}, with measurement errors of $\sim$ 10%. It is interesting to note that the redward shifts are confined to the middle region along the flare ribbons.

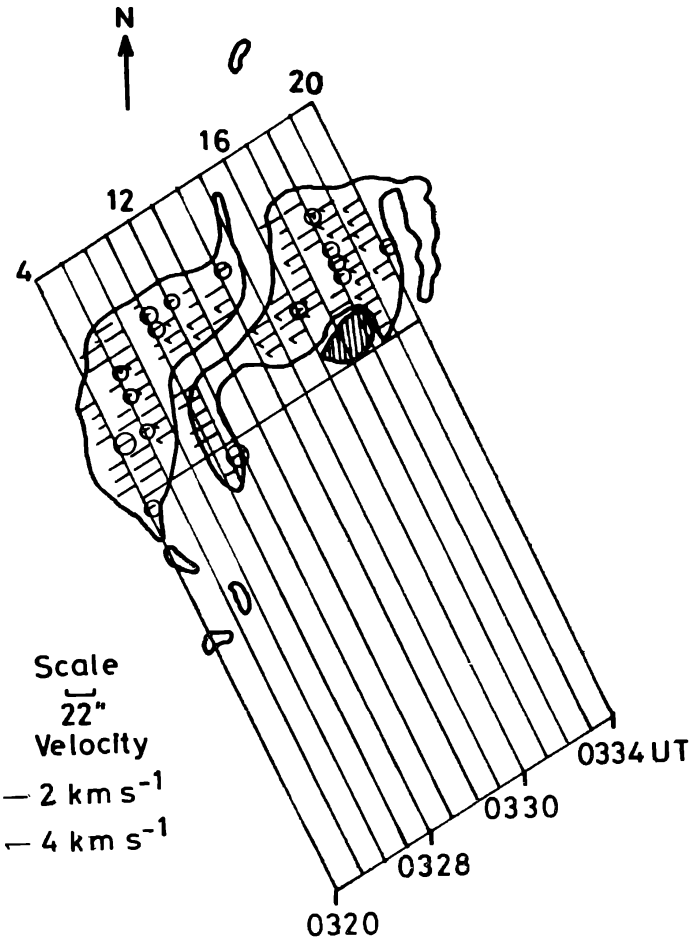

Figure 4. Two dimensional velocity-fields as seen in the K-line of calcium. The numbers on the top indicate the slit position and the figures at the bottom indicate the time in UT. Position of the cross-wire is also shown. The circled vectors indicate red-shift. The spot umbra is shaded.

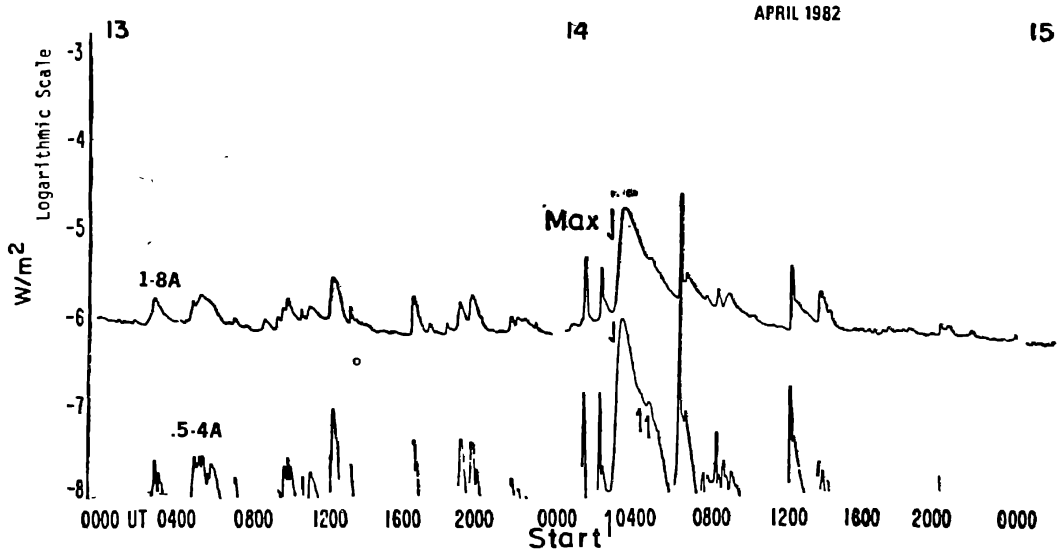

Figure 5. X-ray flux from ion-chamber detector aboard the Space Environment Monitor Satellite (Solar Geophysical Data 1982).

From the time sequence spectroheliograms we have derived the intensity (brightness) contours of the active region plage with raster scans of the densitometer. In figure 2b we show the corresponding brightness contours for plages of the spectroheliograms at two epochs of the event (figure 2a). The brightest regions in the contours for the 0237 UT spectroheliogram show kernel like brightenings and for the 0314 UT spectroheliogram, the innermost contours coincide with the two ribbons. However, the general configuration of the plage as seen in the outermost intensity contour has returned almost to its original pattern. The close relation between the calcium plage and the magnetic field is well known (Leighton *et al.* 1962; Bappu & Punetha 1962; Chapman 1981). On this basis we infer that the general background magnetic field in the active region has regained the original configuration which it had at the preflare phase.

In figure 5, the x-ray flux data (Solar-Geophysical Data 1982) as seen by the ion-chamber aboard the SMS GOES satellite shows the beginning of the enhancement which coincides with the commencement of the flare as observed in the optical region. The optical maximum phase of the flare is also indicated in the figure. The kinks indicated by the other two arrow marks are due to subsequent flares which occurred in the same active region on the sun.

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