MAGNETIC DEVELOPMENT OF FLARING REGIONS AT CENTIMETER WAVELENGTHS

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It has been known for many years that the flare build-up manifests at centimeter wavelengths (2-6 cm), in the form of increased intensity and increased polarization of the active region. The flare-associated bursts originate in these intense sources, and the probability of occurrence of bursts increases with the increasing intensity of these narrow bright regions. With the availability of arc-second resolution using the VLA it has been possible to study the nature of this build-up from two-dimensional synthesized maps over short periods before the start of a flare. For a hard x-ray associated impulsive 6 cm burst observed on June 25, 1980 (Kundu, Schmahl, and Velusamy 1981), we produced several 15-minute synthesized maps in total intensity (I) and polarization (V) just before the flare onset (Kundu 1981). Figure 1 shows the central 1ʹ.1x1ʹ.6 regions of 15 minute synthesis maps over the period 14:45-15:45 UT. As can be seen from these Figures, the region is very complex, consisting of numerous components many of which are bipolar. These components have brightness temperatures of $6-9\times10^6$ K during the hour before the flare. The burst source was located close to the neutral line of these oppositely polarized regions near B. The burst maximum is identified with a "+" and the burst extent averaged over the period 1551-1600 UT is shown by the dotted contour in the last map.

There was a definite trend for the active region undergoing brightness and polarization changes. The central component B intensified at 1515-1530 UT and increased in polarization slightly. In the last map (1530-1545) several new components appeared with polarizations of 40-80%. However, the most remarkable feature is the change of the sense of polarization of component B; also the component on the northern side of B greatly increased in polarized intensity, with polarization of 80-90%. This might imply the emergence of a flux of reverse polarity at coronal levels. (The photospheric magnetograms show little or no change.) We believe that this reverse polarity may be caused by the expansion of a pre-existing flux tube in which twisting increases its coronal magnetic field; at the same time there must be some heating of the loop. Alternately a previously existing loop of opposite polarity

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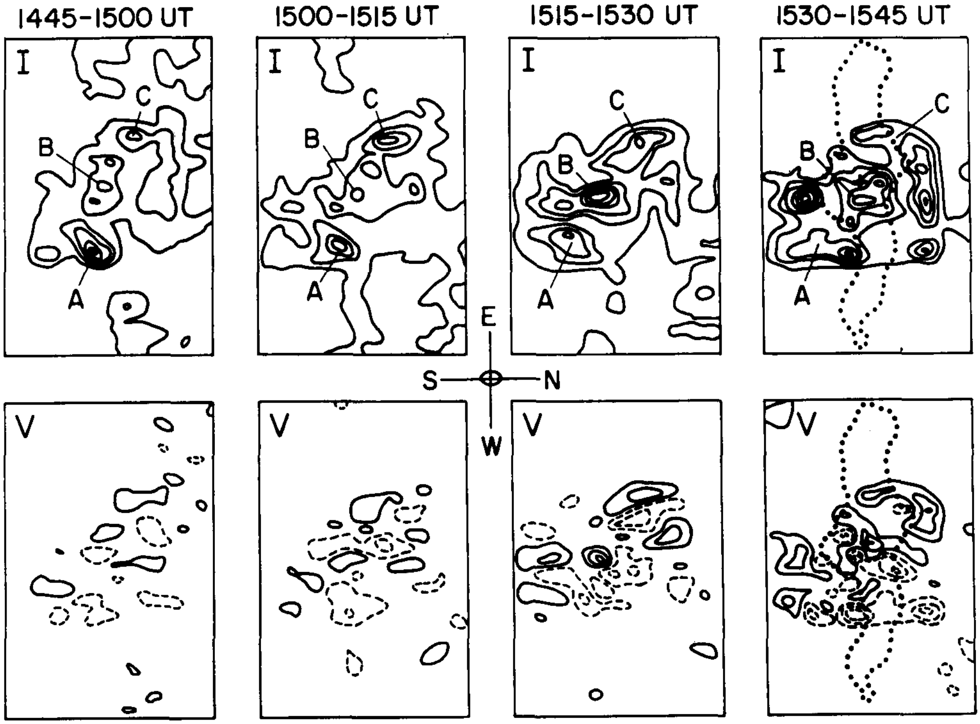
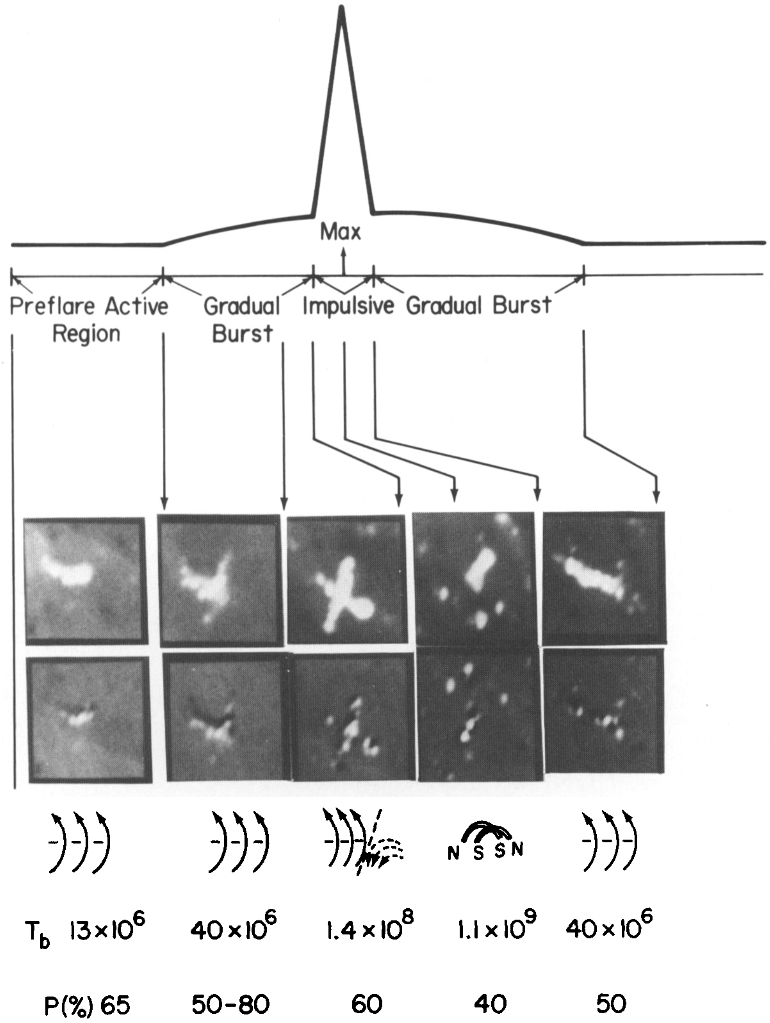


PRE-FLARE 6 CM MAPS 25 JUNE 1980 Fig 1

which was not observable at 6 cm due to its weak magnetic field became observable due to a sudden onset of currents in the loop.

Kundu (1981) and Kundu et al. (1982) discussed a set of 6 cm VLA observations (resolution ~ 2") that pertains to changes in the coronal magnetic field configurations that took place before the onset of an impulsive burst observed on 14 May 1980 (Figure 2). The burst appeared as a gradual component on which was superimposed a strong impulsive phase (duration ~ 2 minutes) in coincidence with a hard X-ray burst. The pre-flare region showed intense emission with peak $T_b \sim 10^7$ K extended along a neutral line situated approximately in the east-west direction. A burst source of intense emission with $T_b \sim 4 \times 10^7$ K, appeared initially. The most remarkable feature of the burst source evolution was that an intense emission extending along the north-south neutral line (line of zero polarization at 6 cm) appeared (Fig. 2), just before the impulsive burst occurred. This north-south neutral line must be indicative of the appearance of a new system of loops, possibly due to reconections. In the 20 seconds preceeding the impulsive peak ($T_b \sim 1.1 \times 10^9$ K) the arcade of loops (burst source) changed and ultimately developed into two strong bipolar regions or a quadrupole structure whose orientations were such that near the loop tops the field lines



were opposed to each other. This quadrupole field configuration is reminiscent of the flare models in which a current sheet develops at the interface between two closed loops. The impulsive energy release must have occurred near one of the centrally located neutral lines. The bright compact bipolar source is obviously related to the region of energy release by some kind of magnetic reconnection of the field lines originating from the two bipolar regions between which this compact region is located.

References

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