Observation of the Magnetic Structure of a Type IV Solar Radio Outburst

J. P. Wild
Radiophysics Laboratory, CSIRO, Sydney, Australia

(Received 15 April, 1969)

Abstract. A continuous record of the 80 MHz image and polarization of a type IV solar outburst has been made with the Culgoora radioheliograph from which the magnetic structure of the event can be directly inferred. The first ('moving') part of the event appears beyond the limb as an expanding magnetic arch along which three concentrated sources develop: one unpolarized source near the peak, attributed to synchrotron radiation; and two polarized sources of opposite polarity near the feet, attributed to plasma radiation. The radio-emitting arch appears to lie above an eruptive prominence seen in Ha. The second ('stationary') part is seen later as a separate highly polarized source on the disk above the projected position of the flare that had previously triggered the prominence activity.

1. Introduction

Observations at 80 MHz with the Culgoora radioheliograph during the past year have revealed, on a number of occasions, arch-like structures reminiscent of the loop prominences or ascending prominences familiar in optical spectroheliograms. At this long radio wavelength one is able to detect matter high in the solar corona (~> 1 R☉) so that the observed structures tend to lie above what is seen optically and are of correspondingly greater scale size. The purpose of this communication is to describe an outburst in which it was possible not only to recognize a loop structure that expanded rapidly beyond the solar limb but also to demonstrate with the aid of polarization measurements that the loop was magnetic in origin. Furthermore the event appeared to be a typical example of a variety of type IV burst in which characteristic 'moving' and 'stationary' parts were clearly distinguished in time and space; indeed the example seems to provide unambiguous clues and restrictions on the kind of model needed to explain such an event.

Fig. 1. Record of total 80 MHz flux during the first 1½ hours of the outburst.

2. Radio Observations

The outburst occurred on 1968 November 22 at 01h and its final phase was still in progress when observations ceased at 04h. The record of total flux at 80 MHz during the first 1½ h is shown in Figure 1, in which the two distinct phases can be recognized. The emission was relatively weak – e.g. the smoothed intensity around the maximum of the first phase was $\sim 10^{-21} \text{ W/m}^2 \text{ Hz}$; the event did not register on the Culgoora radiospectrograph but the appearance of the flux record suggests that most of the emission was continuum.

Radioheliograms at 80 MHz were taken in both senses of circular polarization at 1-sec intervals (for details of the instrument, see Wild (1967)). Selected frames which indicate the progressive development of the outburst are shown in the frontispiece. These coloured photographs were produced by superposing the left and right-handed polarized heliograms through red and blue filters respectively; thus red, blue and white regions correspond to sources of left-handed, right-handed and zero circular polarization respectively.

Fig. 2. Observed geometry of the outburst. The loops beyond the limb indicate the evolution of the expanding magnetic structure of the moving type IV burst inferred from radioheliograms. The times of successive loops, from inner to outer, are those of the frontispiece (b), (c), (d), (e), (g) respectively. A, B, C, D and E refer to radio sources, w and x are Hα flares, y is a dark filament which formed during the outburst and z is an active prominence. The + and − signs indicate magnetic polarity.