THE IMPULSIVENESS OF MICROWAVE BURSTS AND ITS ASSOCIATION WITH SUNSPOT TYPES

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Abstract. A statistical analysis on 220 impulsive microwave bursts showed a marked preference to occur in sunspots of type D, E and F (after Zürich classification). Assuming a shock mechanism for accelerating electrons, this tendency seems to be related to the size of the magnetic loops.

1. Introduction

The association of the sunspot type (after the Zürich classification) with observed flares (Figure 1) by Reid (1968) suggested a brief analogous survey with regard to the microwave impulsive bursts. Even though the period for the radio observations differs from that considered by Reid (1968), we think that this fact does not impair the obtained statistical properties derived from 220 impulsive cases. There is a marked preference for impulsive bursts to occur in spots of type D, E and F as we see in Figure 2. But if we define impulsiveness \( I \) in a linear approximation (Basu and Covington, 1968) we observe the tendency in Figure 3.

2. Discussion

In order to discuss the tendencies we should recall that the associated flares can be explained basically through two approaches: (a) annihilation of antiparallel magnetic fields; (b) current interruption (see e.g. Matsuura and Chu, 1970) as favoured by recent observations (Moreton and Severny, 1968).

We also take into account that the electrons responsible for the synchrotronic radiation of impulsive bursts are accelerated by a shock front, according to the mechanism proposed by Wentzel (Schatzman, 1965). This hypothesis is supported by an analysis of the evolution of the burst's spectrum (Matsuura, 1970), as well as by the coincidence of the explosive phase of flares with the start time of impulsive bursts (Covington and Harvey, 1961). In the 'explosive phase' ejection of material is seen, while the 'flash phase' corresponds to the maximum Hz emission (Zirin, 1966).

In a recently proposed mechanism, in which the current disruption (Matsuura and Chu, 1970) is set up by gyromagnetic drifts, the corresponding electromagnetic emission would be negligible since the electrons are not yet relativistic. Plasma oscillations are likely to occur but emitting at frequencies around 900 MHz. Our microwave frequency is 7 GHz. The delay between the start time of the burst with regard to the flare's start seems to favour the idea that the appearance of a region of high impedance in the current filament (Carlqvist, 1969) is not the direct agent.
of acceleration of charges. Indeed, when the circuit is opened, thermal energy would be released at the expense of the magnetic energy of the current. A heating in the flare's region appears to justify small flux enhancements observed at some frequencies, preceding the impulsive event. These enhancements apparently show a thermal character, with values proportional to the thermal fluxes observed in later stages of the burst (Matsuura, 1970). There must be a magnetic trapping of the particles, but when the internal kinetic pressure increases with temperature and exceeds some critical value, the bottle would expand adiabatically. A rough criterion would be the comparison between the thermal and the magnetic energies

\[ nkT > B^2/8\pi. \]

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Fig. 1a.

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Fig. 1b.