FLARE CHARACTERISTICS AND TYPE III BURSTS : A STATISTICAL APPROACH

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Abstract. An analysis has been carried of the correlation of the occurrence of type III bursts and flares in spotless regions (G-flares) or covering major sunspot umbrae (Z-flares) - i.e. in magnetic conditions presumably opposite - over the past 10 years. A very low correlation of the former flares (8%) and a higher than average value for the latter flares (36% against the normally accepted 25%) shows that the ambient magnetic field of the flaring region is a primary factor for type III burst emission. The presence of a surge and of a rapid brightness rise ("flash-phase") are recognized to be other important, if secondary, factors for type III burst generation.

1. DATA COLLECTION

Flares labelled 'G' (no visible spot in the neighborhood) and 'Z' (major sunspot umbra covered by flare) on the Solar-Geophysical Data bulletins occurring in the period January 1969 to February 1978 have been examined to establish their correlation percentage with type III radio bursts. Flare data from the Solar-Geophysical Data bulletins and our own radio data at 237 MHz were used; a 5 minute tolerance was allowed to take into account uncertainties in flare starting and ending time determination. For the detection of radio events 20 cm/h paper tracings were employed, while high velocity plottings (up to 3 cm/sec) - when available - were used to decide uncertain cases.

In the period considered, about 400 Z-flares and 200 G-flares occurred during our radio patrol observing time; after rejection of uncertain or ambiguous cases the sample was reduced to 375 Z-flares and 176 G-flares. No chance correlation correction factor was applied; the same

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was done for the literature data we took for comparison, in order to have quantitatively comparable results.

2. RESULTS AND DISCUSSION

An average 25 ± 3% correlation value is found in the literature for all flares (Loughhead et al., 1957; Swarup et al., 1960; Malville, 1962; Abrami and Zlobec, 1968): we find 8% for G-flares and 36% for Z-flares. This result strongly suggests that the magnetic field strength in the flaring region is a primary factor in deciding type III burst occurrence; note that the low figure for G-flares could possibly be still lowered by various considerations, among which the chance correlations and the uncertainty of ascribing visually the remark 'G' to a flare (Dodson and Hedeman, 1970; Zappalà, private communication).

This is in contrast with the results of Dodson and Hedeman (1970) and Dodson (private communication) stating that about 1/3 of the flares they observed were accompanied by a type III burst, but it must be remembered that these authors took in exam flares of importance ≥2 while most others (including ourselves) consider also subflares. It is noteworthy that, by taking our whole flare sample (Z and G-flares together) we obtain a 27% correlation value in good agreement with the data in the literature, thus ruling out serious selection effects on our part.

An analysis of the incidence of other distinguishing features within our sample reveals that (both for G and Z-flares) the occurrence of a surge (remark 'H') and a fast brightness rise (remark 'C') are almost twice more common in type III burst-related flares than in burst-less ones. The result for surges confirms the data found by other authors (Giovannelli and McCabe, 1958; Swarup et al., 1960; Malville, 1962; Kahler, 1973) even quantitatively. It is interesting to note that, while surges are the most repetitive solar optical phenomenon (with a typical rate of about one hour - see Švestka, 1976), type III burst groups also show at times remarkable repetitive characteristics (spectrum shape, polarization, duration) with a comparable rate (e.g. on August 12, 1975 - see Benz et al., 1977). From a theoretical point of view, the presence of a surge, implying a free path for the rise of underlying matter, is the mark of a favourable situation for the occurrence of radio bursts.

As regards the flare characteristic 'C' (invisible 10 minutes before), we consider it as connected to the existence of a so-called "flash-phase"; lacking systematic recording of this feature, we adopted the approximate criterion "flare maximum time - flare starting time ≤ ≤ 5 minutes" to recognize the occurrence of such a phase. Both G and Z-

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-flares in our sample resulted in showing this feature in about 60% of cases, and in both the presence of this fast initial brightness rise enhances the correlation with type III bursts of about 10%. Since the flash-phase is an explosive phenomenon, its relation to type III burst emission (through the generation of accelerated electron streams) seems quite acceptable.

3. CONCLUSIONS

From a purely observational research we derive that a strong connection exists between type III burst emission and the magnetic field strength in the flaring region. Secondary to this, other important factors that influence type III burst generation are the presence of a surge and of a rapid brightness rise. While the explanation of the effect of these secondary features on type III burst occurrence appears straightforward - at least qualitatively - the role of the primary agent (the magnetic field conditions) will need in our opinion further investigation.

REFERENCES

Abrami,A. and Zlobec,P.:1968,Mem.Soc.Astron.Ital.XXXIX,4,pp.557-567.

Benz,A.O.,Berney,M. and Santin,P.:1977,Astron.Astrophys.56,pp.123-127.

Dodson,H.W. and Hedeman,R.H.:1970,Solar Phys.13,pp.401-419.

Giovannelli,R.G. and McCabe,M.K.:1958,Australian J.Phys.11,pp.191-199.

Kahler,S.W.:1973,Solar Phys.32,pp.477-484.

Loughhead,R.E.,Roberts,J.A. and McCabe,M.K.:1957,Australian J.Phys.10, pp.483-492.

Malville,J.M.:1962,Astrophys.J.135,pp.834-846.

Švestka,Z.:1976,"Solar Flares",Reidel,Dordrecht,Ch.4,pp.221-223.

Swarup,G.,Stone,P.H. and Maxwell,A.:1960,Astrophys.J.131,pp.725-738.