RADIO-ASTRONOMICAL EVIDENCE FOR MAGNETO-HYDRODYNAMICAL PULSATIONS IN THE CORONA

HANS ROSENBERG

Observatory 'Sonnenborgh', Utrecht, The Netherlands

At Utrecht Observatory a 60-channel solar radiospectrograph has been in regular operation since the fall of 1968, in the bandwidth 160–320 MHz, with a time resolution of $0^s.03$ (De Groot and Van Nieuwkoop, 1968). In addition to all generally known and classified emissions as noise storms, type IV bursts, type III bursts, type IV continua, a number of unclassified emissions have been observed. The spectrograph is particularly well suited to study short time scale fluctuations, even of small amplitude. One striking feature is an often recurring broad band (>80 MHz) weak, quasiperiodic fluctuation superimposed on a type IV-like continuum (Figure 1). Since no interferometric measurements were available, it is not known whether it is a stationary or a moving type IV burst. However, due to the sometimes very long duration, we expect it to be a stationary type IV.

We have suggested (Rosenberg, 1970) that the fluctuation in the synchrotron radiation causing the type IV emission is due to the fluctuation of the local magnetic field strength. The time scale of such a fluctuation will in general be determined by the Alfvén-velocity and the characteristic length of the magnetic field inhomogeneities, in the direction perpendicular to the magnetic field. Assuming field strengths in the order of 3 G and local densities of 10^8 cm^{-3}, while using a characteristic time of $0^s.3$, the scale of the inhomogeneities equals 1000 km, in accordance with optical and radio measurements (Hewish and Symonds, 1969; Dennison, 1969; Van de Hulst, 1950).

Often a low-frequency cutoff is observed around 220 MHz, which has also been noted by other observers (Takakura, 1963; Takakura and Kai, 1961) and has been explained by Ramaty and Lingenfelter (1967) and others as being a suppression of the synchrotron emission due to the influence of the ionized medium (Razin effect). In some cases, however, the ridges bend towards later times at the lower frequencies (Figure 2). We think this to be due to group retardation effects as proposed by Jaeger and Westfold (1950) when they tried to explain type III bursts by this process. This will be investigated in more detail.

On some occasions type I storms have been observed, during which the type I bursts did not occur in chains (as they generally do), but were more situated on the intensity maxima of the underlying pulsating structure (top of Figure 1).

Finally in a few examples we found groups of type III bursts starting from a pulsating structure, where again every type III burst seemed to be associated with a maximum in the pulsating structure.

We therefore propose the following model, which we are studying in more detail at present. The pulsating structure is due to synchrotron radiation in a force-free

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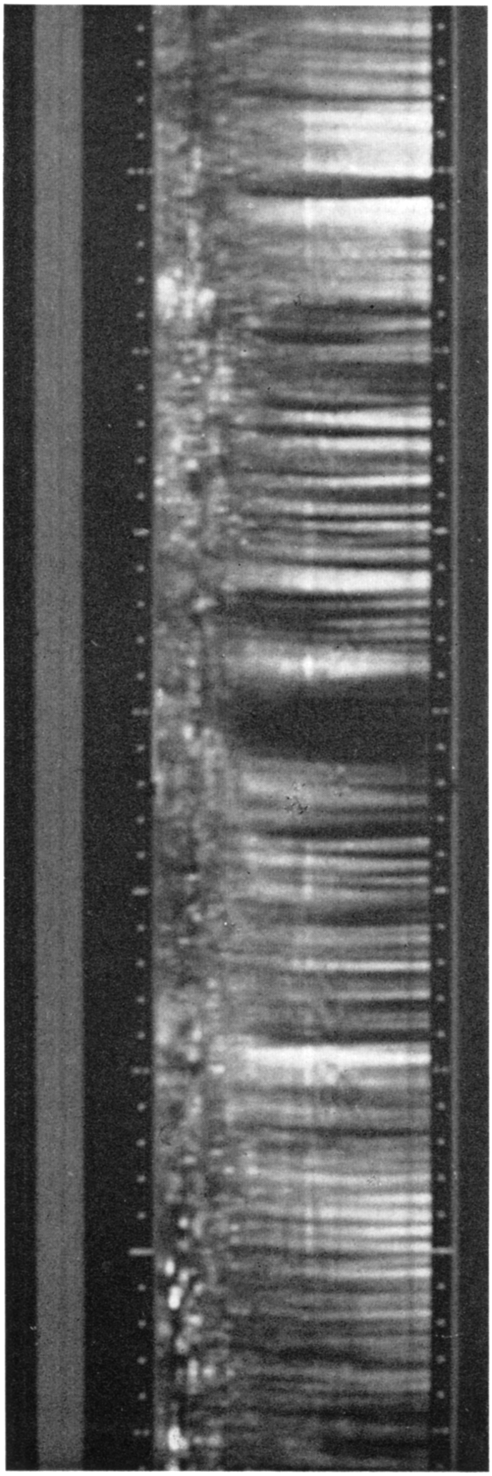

Fig. 1. 25 February 1969; $09^h08^m54^s$–$09^h09^m34^s$; 160 MHz at top, 320 MHz at bottom of the picture; distance between two dots equals one second.

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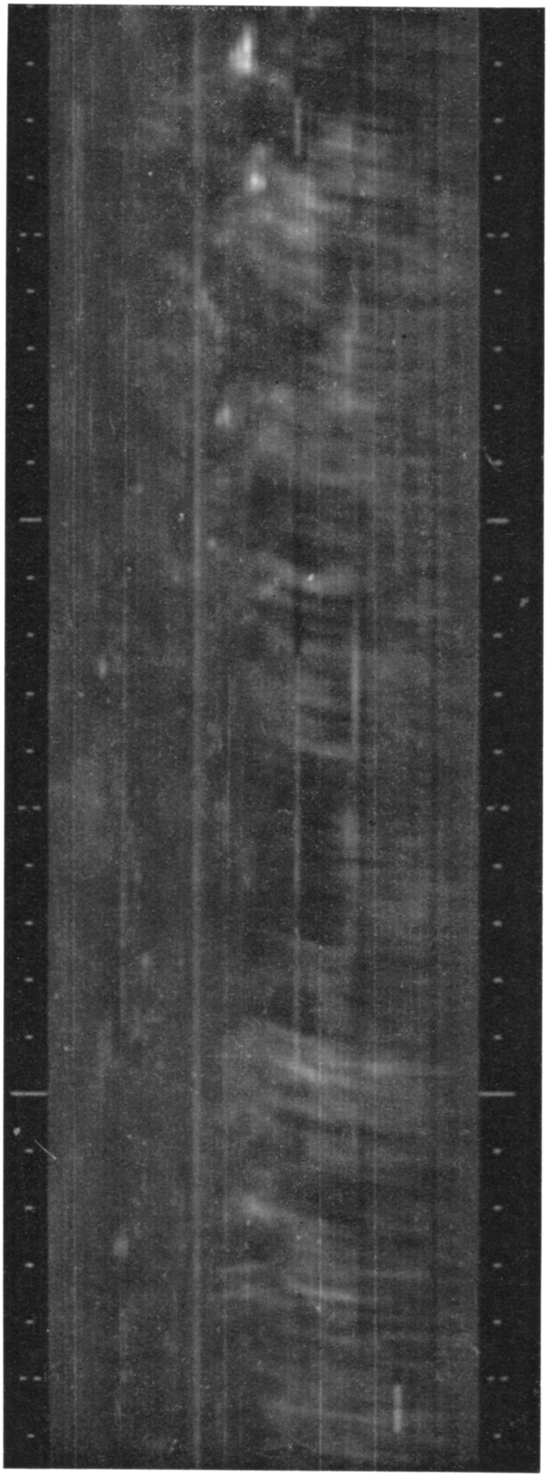

Fig. 2. 10 June 1969; $15^h03^m54^s$–$15^h04^m19^s$; curved pulsating structure.

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magnetic flux tube which may reach quite high into the corona. A compression of the tube, thus enhancement of the field strength, corresponds to a maximum in intensity, an expansion to a minimum. The mechanism responsible for the type I radio-bursts seems to be preferentially active at the maximum field strength.

The release of fast charged particles, causing type III bursts, also seems to occur at the moment of highest intensity of the flux tube. These fast particles are apparently stored in the flux tube and can be released periodically at the moments of highest compression.

The stability of such a flux tube has been studied in recent years by a number of people (Callebaut and Voslamber, 1962; Anzer, 1968), finding seemingly contradicting results. It is quite certain that a very long and thin flux tube will be unstable. However the critical numbers for which stability is obtained are not available yet. Furthermore the influence of the bending of a straight flux tube (with a helical field) into a semi-circle on the stability, and the effect of the solar wind has to be taken into account. This programme is at present being carried out at the Utrecht Observatory.

References

Anzer, U.: 1968, *Solar Phys.* **3**, 298.
Dennison, P. A.: 1969, *Planetary Space Sci.* **17**, 189.
Groot, T. de and van Nieuwkoop, J.: 1968, *Solar Phys.* **4**, 332.
Hewish, A. and Symonds, M. D.: 1969, *Planetary Space Sci.* **17**, 313.
Hulst, H. C. van de: 1950, *Bull. Astron. Inst. Neth.* **11**, 150.
Jaeger, J. C. and Westfold, K. C.: 1950, *Australian J. Sci. Res.* **A3**, 376.
Ramaty, R. and Lingenfelter, R. E.: 1967, *J. Geophys. Res.* **72**, 879.
Rosenberg, H.: 1970, *Astron. Astrophys.* **9**, 159.
Takakura, T.: 1963, *Publ. Astron. Soc. Japan* **15**, 327.
Takakura, T. and Kai, K.: 1961, *Publ. Astron. Soc. Japan* **13**, 94.
Voslamber, D. and Callebaut, D. K.: 1962, *Phys. Rev.* **128**, 2016.

Discussion

Boischot: How intense are the fluctuating structures compared to the intensity of the continuum?

Rosenberg: The amplitudes are very variable. During the short ($\tau \sim 0^s.3$) pulsations they may be only a few percent, but we have observed long pulsations ($\tau \sim$ a few seconds) with amplitudes of 20–30%.