MILLISECOND STRUCTURES IN SOLAR RADIO EMISSION CLOSE TO 264 MHz

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Abstract. High-time resolution spectral measurements of solar radio emission close to 264 MHz are reported. Instrumental resolutions of the order of a few kHz in frequency and tenths of milliseconds in time were used to resolve the burst fine structure in the time-frequency plane. Fine structures, having narrow bandwidths and durations of some 5 to 30 ms, have been observed mostly in association with type I and type III bursts. These very short duration bursts have negative frequency drifts of about $-50$ to $-60$ MHz $s^{-1}$. They can occur individually or in small groups where they sometimes display a quasi-periodicity of a few milliseconds.

1. Introduction

Fine structures, within the solar radio emission spectrum, have been reported by a number of workers over the past twenty years. These noise bursts, having durations less than 1 s, have been referred to variously as spike bursts, flash bursts, fast pulses, fast drift storm bursts or drifting spikes.

Millisecond duration structures have been reported by Slottje (1978) at microwave frequencies and by Barrow and Saunders (1972) and by McConnell (1980, 1982), at decametric frequencies. Fine structures were also observed by Dröge (1977) at fixed frequencies within the range 200 to 1000 MHz while Elgarøy (1979) reports drifting spikes close to 500 MHz. It is clear that considerable detail exists in the solar spectrum beyond the traditional longer duration burst types.

We now report the first high-resolution spectral observations at metre wavelengths where we have found fine structure bursts, with durations of some 5 to 30 ms, close to 264 MHz and mostly in association with type I and type III bursts. These structures appear to be different in character and shorter in duration than the spike bursts recently reported by Benz et al. (1982) and the pulsating structures in type IV bursts described by Abrami and Koren (1978).

2. Observations

The observational procedure was based upon the variable resolution radio spectrograph, developed at the University of Florida by Krausche et al. (1976), to study jovian decametre-wave millisecond or S-bursts.

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The receiving equipment consisted of a 5 m dish with a broadband, linearly polarized, log-periodic feed. The 2 MHz wide data bandwidth, centred on 264 MHz, was heterodyned to baseband using a triple conversion receiver and the undetected baseband recorded, direct mode, by a high-speed analog instrumentation tape recorder. The receiver/recorder linear dynamic range was more than 25 db above the system noise floor.

The data tapes were slowed down 128 times for playback, compressing the original 2 MHz bandwidth to 15 kHz, and analyzed using the University of Florida Radio Astronomy Group's 200-channel real-time spectrum analyzer. The analyzer output Z-modulated an oscilloscope and was recorded on continuously moving 35 mm film to give a conventional time-frequency-intensity dynamic radio spectrum.

The analyzer synthesized 200 adjacent channels, each having a bandwidth of 100 Hz. Since the data was slowed down by a factor of 128, the effective filter bandwidth was 12.8 kHz with a corresponding response time of 78 \( \mu s \). The analyzer output was, in fact, undersampled yielding independent outputs effectively every 312 \( \mu s \). The spectrograph resolution pixel thus had dimensions of 12.8 kHz \( \times \) 312 \( \mu s \).

Krausche et al. (1976) have drawn attention, with respect to fast structures in the Jupiter radio emission, to the difference in appearance of bursts observed at single fixed frequencies and bursts observed spectroscopically. This distinction is apparent in Figure 1 where a diagram, originally due to Tarnstrom and Philip (1971), is modified.

Fig. 1. Schematic representation of a fine structure burst as seen by the high-resolution receiving system where \( d_o \) is the burst lifetime, \( d_f \) is the observed duration, \( b_o \) is the burst frequency range, \( \Delta f \) is the receiver bandwidth and \( df/dt \) is the frequency drift rate. With the present receiving/processing system slowdown of 128 : 1, the 2 MHz receiver bandwidth (\( df_f \)) was resolved into 156 adjacent 12.8 kHz-wide channels, each producing 3200 independent samples per second.