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OBSERVATIONS ON THE TIME STRUCTURE OF SOLAR RADIO BURSTS AT A WAVELENGTH OF 12 M

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Extensive observations on the time structure of solar radio bursts of Type I have been made in the frequency range 100 MHz and above by Elgaröy (1961), De Groot (1966), De Jager and Van 't Veer (1958) and others. Many important conclusions regarding the generation and propagation of these bursts have been arrived at on the basis of these observations. It is important to test the validity of these conclusions at lower frequencies. Apart from the observations of Yoh and James (1967) wherein they reported the discovery of short duration narrow band bursts at 38 MHz, no measurements have been previously reported at sufficiently low frequencies. In this note we present the results of observations made at a frequency of 25 MHz.

The antenna used in the present observations is one of the arms of the 25 MHz interferometer at this observatory. It is a broadside array of 36 full wave dipoles with a gain of approximately 20 db. The receiving system is of the conventional type with a bandwidth of 13 kHz, and a time constant of 0.01 sec. The radio bursts are recorded on a Ediswan pen oscillograph with paper speeds of 0.75 to 3.00 cm/sec.

The radiometer was operated during periods of enhanced solar emission and so most of the bursts recorded are storm bursts or bursts of Type I. The enhanced radiation is found to be composed of bursts both compound and elemental of durations ranging from less than $\frac{1}{2}$ sec to several seconds. The bursts appear to be superimposed on slowly varying (several seconds) enhanced continuum. Out of the several hundred bursts recorded only those isolated bursts with a simple rise and fall were selected for

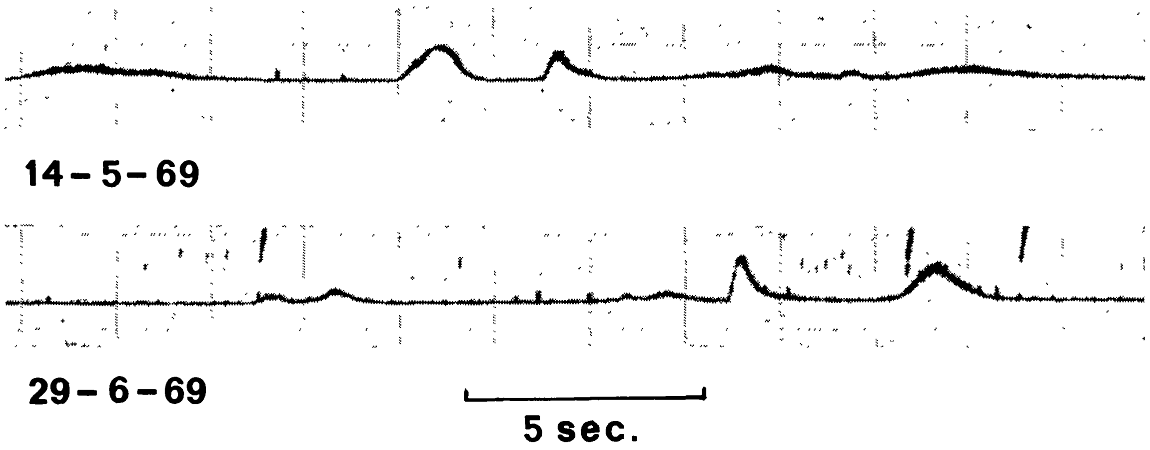

Fig. 1. Examples of isolated bursts used for duration determinations. The narrow spikes are due to atmospherics.

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duration determinations. The time interval between half power points of a single burst has been chosen as its duration. Figure 1 shows typical examples of bursts chosen for the above purpose. The distribution of the number of bursts with various durations is given in Figure 2. It can be seen that a majority of the bursts have durations less than 2 sec. The average of all the bursts with durations less than 2 sec is 1.01 sec. Sometimes bursts of extremely short durations of the order of 0.2 sec have been recorded. These bursts are accompanied by irregular variations of the enhanced radiation. These bursts are probably similar to the Flash bursts reported by Elgaröy (1965).

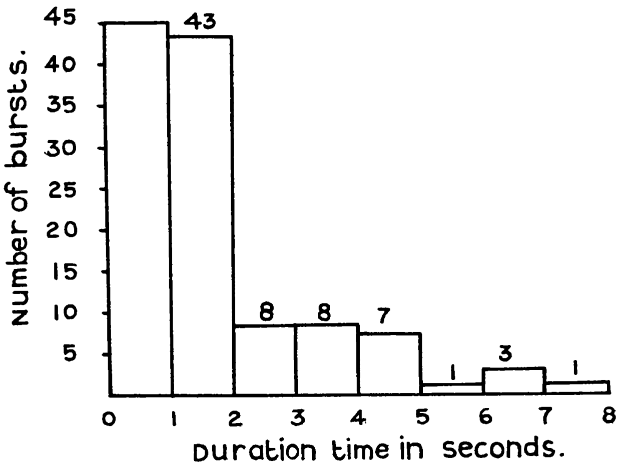

Fig. 2. Histogram showing the distribution of the number of bursts with various durations.

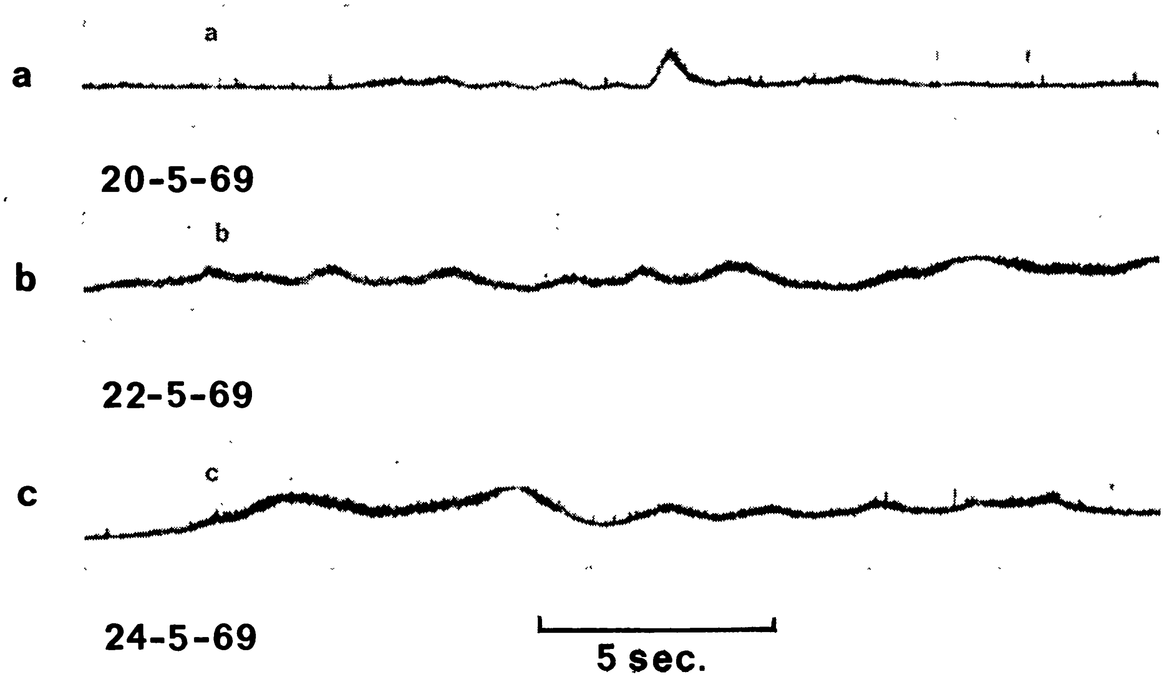

Fig. 3. Oscillatory variations of the enhanced radiation.

On several occasions it is found that the enhanced radiation exhibits distinct periodicities. It can be seen from Figure 3a that on May 20, 1969 there was an oscillatory variation of the enhanced radiation with a period of about 3 sec just before the onset of the large burst. Several bursts of similar amplitude were recorded on that day but the periodic variation of the enhanced radiation was not present at any other time. Part of the record obtained on May 22, 1969 is reproduced in Figure 3b. One can again see the oscillatory variations of the enhanced radiation. The enhancement on this day lasted for about 35 min and it is almost completely devoid of the usual short duration bursts. Instead there were quasi-sinusoidal variations with periods ranging from 3 to 8 sec. Another oscillatory variation recorded on May 24, 1969 is shown in Figure 3c. On this day many short duration bursts were recorded before and after the oscillatory variation but the oscillations were not repeated again. Similar oscillatory variations were reported by Abrami (1968) at a frequency of 239 MHz.

Several double humped bursts of the type first described by Payne-Scott (1949) were recorded. Occasionally two bursts with similar characteristics appear together. Typical examples of these bursts are shown in Figure 4. It is found that on the average the time delay between the two bursts is of the order of 1.7 sec. It is also found that the second burst is generally of comparable intensity or more intense than the first one.

It is generally assumed that the burst radiation is due to plasma oscillations. Based on the observations made at frequencies of 100 MHz and above Takakura (1963) argued that the burst duration is too long to be determined by the collision damping time of the plasma oscillations. Therefore, he proposed that the burst durations are more likely to be determined by the life times of the electron streams. But, it can be

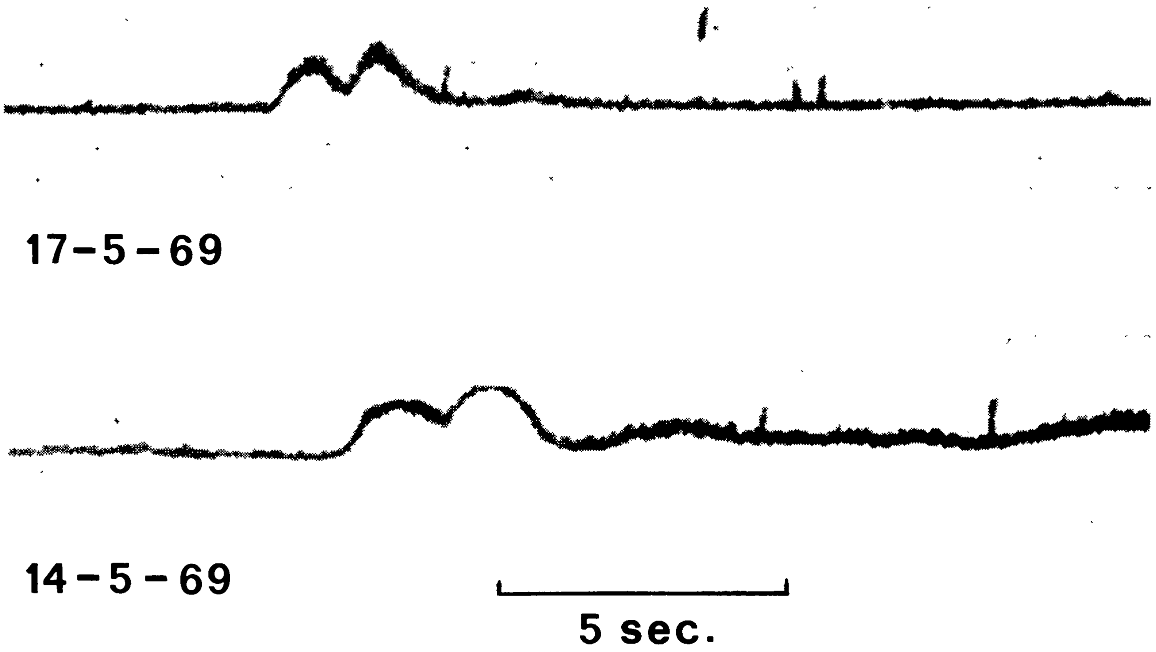

Fig. 4. Typical examples of double humped bursts.

shown using the expressions derived by Spitzer (1956) that the mean collision time of thermal electrons at a temperature of 10^6 K and at a plasma density for 25 MHz, will be about 1.4 sec. It is interesting to note that this is of the same order as that observed at 25 MHz.

The double humped bursts were explained as coronal echoes by Jaeger and Westfold (1950). According to the theory of echoes developed by Roberts (1958), the time delay between the two bursts will be about 4 sec at a frequency of 25 MHz, if the source is at the center of the solar disk. The delay decreases if the source is away from the center of the disk. So the observed delay is not entirely incompatible with the theoretical prediction. But the observation of the second burst being either equal in intensity or more intense than the first is difficult to explain on the basis of this theory. Therefore, it would appear that some other process such as the magneto-ionic splitting suggested by Roberts (1958), and Elgaröy (1969) may be responsible for the origin of these bursts.

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