ON THE CORRELATION BETWEEN EXCITER DURATION AND DECAY CONSTANT OF SOLAR DECAMETER TYPE III RADIO BURSTS

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Abstract. It is observed that while there exists a strong correlation between the decay constant and the exciter duration for isolated type III radio bursts, it is absent for those type III radio bursts which are preceded by type IIIb radio bursts. A possible theoretical explanation for the presence of correlation in one case and lack of it in the other is proposed.

1. Introduction

It was first pointed out by Aubier and Boischot (1972) that it is possible to derive the duration of the exciter $D_e$ and the decay constant $\tau$ from the time profile of type III radio bursts under certain assumptions. They also showed that these two parameters are positively correlated. These results are confirmed by Barrow and Achong (1975) and also Poquerusse (1977). We have measured the exciter durations and decay constants for isolated type III radio bursts and also for those type III bursts which are preceded by type IIIb bursts (hereafter referred as associated type III bursts) and the results are reported here. We find that $D_e$ and $\tau$ are strongly correlated for isolated type III bursts, whereas such a correlation does not seem to exist for associated type III bursts. An attempt is made to explain the observed results on the basis of the characteristics of the beam-plasma system responsible for the generation of the type III radio bursts.

2. Observations

These observations were made during the period January 1971 to March 1972 using an antenna system of about 25 dB gain and a multichannel receiver. Most of the data in the present analysis was collected during the period July–August 1971. The center frequency was 25 MHz, the bandwidth and the time constant were 13 kHz and 10 m respectively. The channel separations were usually 100 kHz but can be varied from 20 kHz onwards. Details of this equipment were given in Sastry (1972, 1973). Typical examples of type III bursts and the preceding type IIIb bursts are given in Krishan et al. (1980).

3. Results

Following the procedure of Aubier and Boischot (1972), the exciter durations and the decay constants were measured for 52 isolated type III bursts and for 32
associated type III bursts. The error in the measurement of the exciter duration for each type III burst is ±0.5 s and that in decay constant is ±0.3 s. The measured values of $D_e$ and $\tau$ vary from burst to burst and the mean value of $D_e$ and $\tau$ in the case of isolated type III bursts are 4.8 s and 2 s respectively. A scatter diagram of $D_e$ and $\tau$ is shown in Figure 1a. One can see that the two parameters are positively correlated and the linear correlation coefficient is 0.7. In the case of associated type III bursts, the mean values of $D_e$ and $\tau$ are 6.5 s and 1.9 s respectively. Figure 1b shows a scatter diagram of $D_e$ and $\tau$ for this case and it is clear that the correlation is very weak. The linear correlation coefficient is 0.2.

4. Discussion

A fast electron beam propagating through the corona is believed to be responsible for the excitation of type III solar radio bursts. The type IIIb radio bursts are probably produced when the strength of the electric field of the electrostatic beam plasma instability exceeds the threshold for the excitation of the side band instability, Smith and de la Noe (1976) and Krishan et al. (1981). The duration of the exciter is the time taken by the electron beam to cross any given plasma level in the corona. Aubier and Boischot (1972) have already pointed out that the observed correlation between $D_e$ and $\tau$ is difficult to explain on the basis of collisional damping of plasma waves. Many authors (Zaitsev et al., 1972; Takakura et al., 1973) believe that the main damping mechanism is probably non-collisional. The damping of type III bursts could be due to the absorption of energy by the particles with velocity smaller than the phase velocity of the wave during the induced wave particle scattering. In this