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DIFFUSE ECHO BURSTS AT 34 5 MHz

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Introduction

The solar radio bursts during their propagation towards the earth are refracted, scattered reflected and absorbed The combination of these effects play a role in determining the source size, position, brightness temperature and time profile of solar bursts at the earth The sporadic radio emission of the sun in some cases reveal features which are called "echo like' These echo bursts occur during periods of decameter storms Abranin et al (1982, 1984) first reported these diffuse echo bursts at 25 MHz We present here further observations on these bursts at a frequency of 34 5 MHz

Observations

These bursts were observed with the south arm of the Gauribidanur Radio Telescope operating at 34 5 MHz The receiver system is a multichannel filter band spectral receiver with a total bandwidth of 400 KHz and band separation of 50 KHz Each channel bandwidth is 15 KHz The time constant used is 10 msec The output of the system is recorded both in analog and digital form

During the period 11th to 23rd June 1982, a noise storm activity was seen at decameter wavelengths The number of diffuse echo bursts seen during this period is large although these bursts have been seen during other periods of activity also Fig 1 shows a typical example of a diffuse echo burst

Frequency Characteristics

The drift rate df/dt of the two elements of the burst were measured from the peak of the burst at two frequencies The drift rate of both the elements are of the same sign The drift rate can be either +ve or ve The drift of the first element varies from 50 KHz to 1 MHz The drift rate of the second element also lies in the same range

The bandwidth of the first element varies from 50 KHz to 400 KHz The bandwidth of the second element is always greater than that of the first element

Time Profile Evaluation

We measured the time delay ΔT_1 between the peaks of the two elements of the burst The time delay ΔT_1 is found to vary with the heliolongitude of the active region During the period of observation, a number of active regions were seen optically Since position information of the noise storm at 34 5 MHz is not available, the heliolongitude of the noise storm at 160 MHz were taken from the Culgoora measurements given by R T Stewart et al (1985) The maximum time delay of 3 8 sec occur when the active region is at heliolongitude of 22° and minimum time delay of 1 8 sec occur when the heliolongitude is less than 12° In cases where there is a second echo the time delay ΔT_2 is found to be well correlated with ΔT_1 with a linear correlation coefficient 0 86 as shown in Fig 2 The total duration of the burst is also found to be correlated with ΔT_1 with a linear correlation coefficient of 0 84 as shown in Fig 3

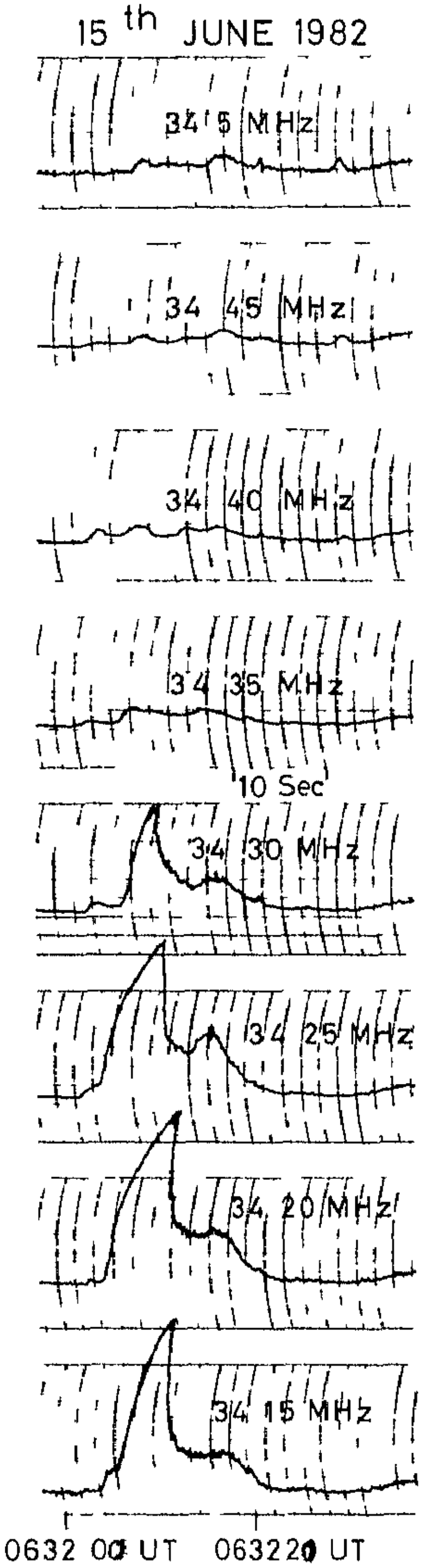

Fig. 1 Typical example of diffuse echo bursts The time marks are at interval of 20 sec

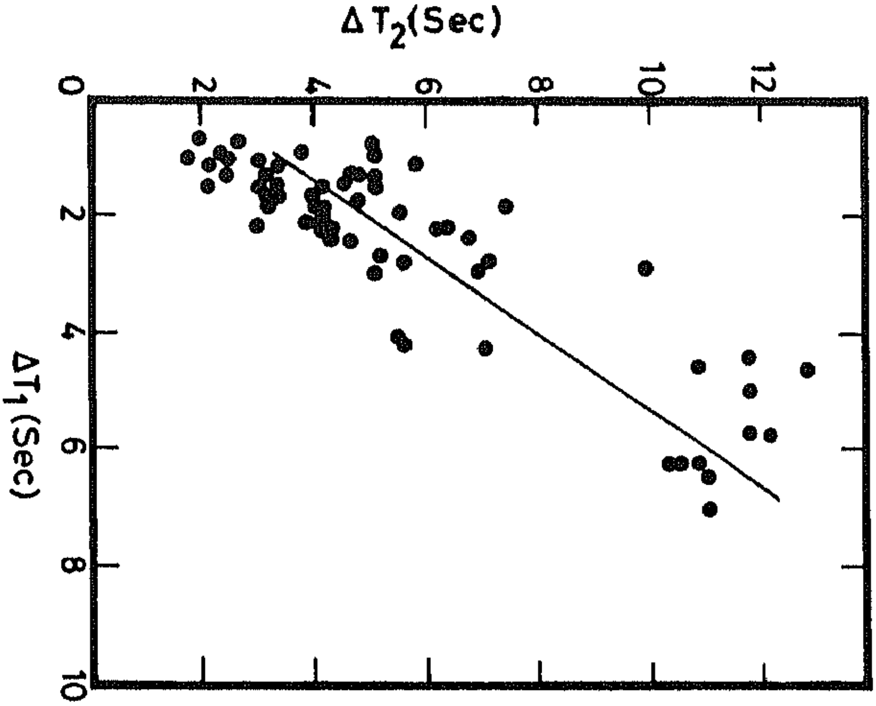

Fig 2 Plot of the time delay between the primary burst and the first echo versus the time delay between the first echo and second echo

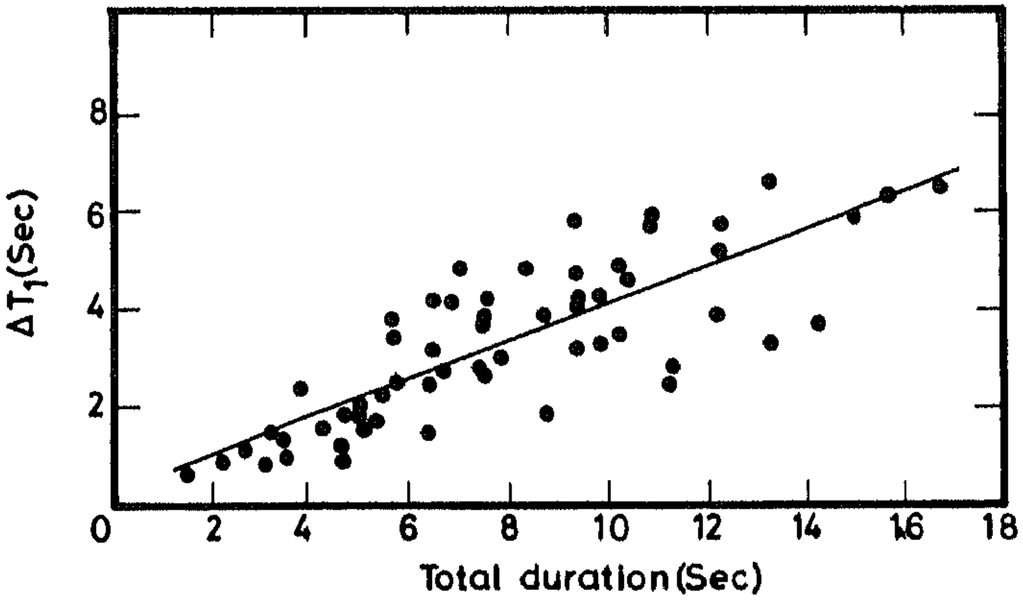

Fig 3 Plot of total duration versus the time delay

Discussion

From the drift rate of diffuse echo burst one can calculate the velocity of the exciter of the burst for the Newkirk's electron density model given by

$$Ne(\rho) = 4\ 2 \times 10^{4} \times 10^{4\ 32/\rho}\ \mathrm{cm}^{3}$$

the drift rate is given by

$$\frac{df}{dt} = 8\ 7 \times 10^{2}\ \beta f\ [\ell n(0\ 54)]^{2}\ \mathrm{MHz/sec}$$

where β - V/C and f in MHz For the diffuse echo bursts the average velocity of the exciter is 5500 Km/sec Shock waves in the corona have typical velocity of ≈ 600 Km/sec and only in very few cases reach velocities > 2500 Km/sec The required velocity of electron beam to generate Langmuir waves is much higher than 5500 Km/sec Therefore the exciter may be an Ion beam

The instantaneous bandwidth of the echo bursts provides an upper limit to the vertical dimension Δr given by

$$\Delta r < (df/dr)^{1}\ \Delta f$$

The vertical dimension of the first element lies in the range of 3600 Kms to 28000 Kms The second element dimension is always greater than 28000 Kms The increase in size of the second element may be due to the scattering of the radiation by filamentary structures in the model of Riddle (1974)

Riddle has computed the time profile at 1 AU resultisng from a short burst of 80 MHz emitted from the 78 MHz plasma level, followed by the emission of a similar burst of 80 MHz (harmonic of 40 MHz) from the 40 MHz plasma level The model radio echo is in the form of a longer duration low intensity burst preceded by the short duration burst seen as a direct ray One can apply this model in the case of diffuse echo bursts as they occur at the second harmonic of the plasma frequency as found by Tsybko (1984)

The harmonic of 17 25 MHz (i e 34 5 MHz) is emitted directly towards and away from the observer The emission towards the sun gets reflected from the 34 5 MHz plasma level and reaches the observer as an echo On its way towards the 34 5 MHz plasma level the radiation encounters numerous filamentary structures which can increase the size of the second element and hence the bandwidth

The time delay between the primary burst and the echo is given by

$$\Delta T_1 = 2(R_2\ \ R_1)/C + T_g$$

where R_2 and R_1 are the coronal heights corresponding to frequency of 17 25 and 34 5 MHz and T_g is the group delay that a radio wave experiences along the path from R_2 to R_1 The value of T_g is ≈1 sec at decameter wavelengths From the maximum value of ΔT_1 (4 sec) R_2 R_1 is given by 0 64 $R_\odot$ which agrees with coronal model given by Newkirk The once reflected radio wave can be reflected again on its way towards the earth if it encounters electron density irregularities of required density

Conclusion

The slow drift rate of the diffuse echo burst shows that the exciting agent may be on ion beam The increased bandwidth of the second element can be due to the scattering by the density irregularities

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