COMPLEMENTARY BURSTS, CORONAL INHOMOGENEITIES AND NEW MICROSCOPIC SPECTRAL FEATURES OF SOLAR BURSTS IN TYPE IV BURSTS

H.S. Sawant*, R.V. Bhonsle, S.S. Degaonkar
Physical Research Laboratory, Ahmedabad-9, India

and

T. Takakura
Tokyo Astronomical Observatory, Mitaka, Tokyo, Japan

ABSTRACT

Complementary bursts (C.B's) have been observed in the decametric range during noise storms and/or type IV activity. These bursts essentially consist of two components, each component having a duration ~ 1 second. The first component shows weak emission or emission gap over a certain frequency range. The second component is observed after a certain delay. If the bursts are assumed to be generated at the fundamental, and if the radiation corresponding to the gap propagates through an electron density irregularity located close to the source along the line of sight, whose cross-section is less than the linear extent of the source, then almost all properties of the C.B.'s can be explained. High sensitivity, and high frequency and time resolution spectra of type IV bursts at 137 MHz revealed new microscopic spectral features displaying "wave-like" and "fork-like" shapes.

INTRODUCTION

A dynamic spectrum analyzer of high frequency and time resolution was built at the Physical Research Laboratory, Ahmedabad to study solar radio bursts at decametric wavelengths. The spectrum analyzer scanned a frequency interval of $\pm$ 0.5 MHz near 35 MHz, with frequency resolution of 5 kHz and time resolution of 10 ms. It was operated daily during the period July 1974 to April 1976. During this period this instrument revealed a new microscopic burst feature, which was designated as "Complementary burst" (Sawant et al., 1975). The first part of this paper deals with the observations of "Complementary bursts" and their interpretation. The second part describes the new microstructures observed in the high sensitivity dynamic spectra at 137 MHz of type IV bursts.

*Present address: University of Maryland, Clark Lake Radio Observatory, P.O. Box 128, Borrego Springs, California 92004, USA.

M.R. Kundu and T.E. Gergely (eds.), Radio Physics of the Sun, 269-271.

I. Salient Features of "Complementary Burst"

Most C.B.'s were observed during noise storms or type IV bursts. Examples of C.B.'s are displayed in Figure 1. These bursts essentially consist of two components, each component having a duration of $\sim$ 1 sec. The first component shows weak emission or emission gap over a certain frequency range. The frequency drift rate of the first component is about 1 MHz/sec. The frequency range of the second component is approximately equal to that of the emission gap observed in the first component. The frequency drift rate of the second component is lower than that of the first one. The time delays between the first and second component peak around 1-2 seconds and 10-15 seconds (Sawant et al., 1975).

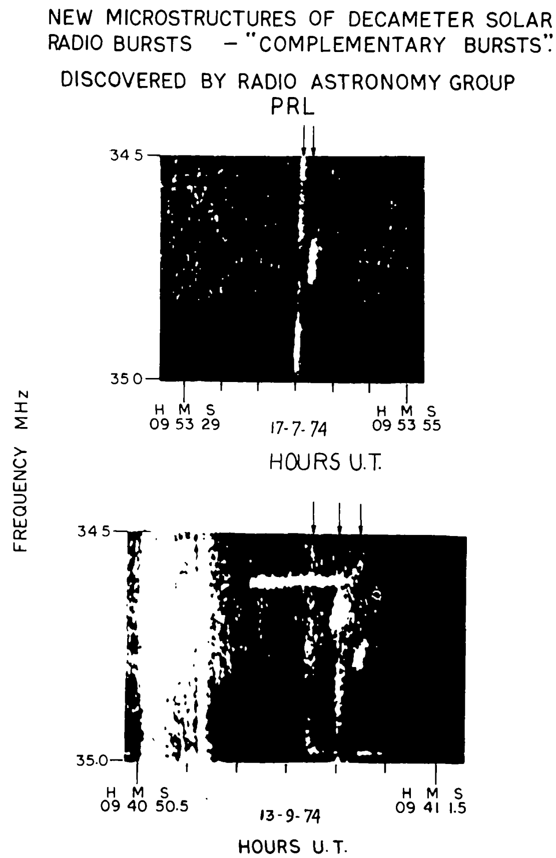

Figure 1. Dynamic spectra of solar bursts near 35 MHz showing "Complementary Bursts".

INTERPRETATION

If the radiation is assumed to be generated by a plasma process throughout the source region, then emission gap of the first component may be explained, provided that the radiation corresponding to the gap propagates through an electron density irregularity whose cross-section is less than the linear extent of the source, thus producing the observed time delays.

In order to explain the observed time delay $\sim$ 1 second, it is necessary for this irregularity to have an excess electron density of about 1 to 2 percent, over that of the ambient corona near the source. It can be shown that $V_g = \frac{cV_t}{V_e} \simeq 10^4$ km/s where V = group velocity of e.m. waves, V_t = thermal velocity of electrons and V_e = exciter velocity (0.3 c). Therefore, the delay of the order of 1 second occurs if the size of irregularity is of the order of 10^4 km. The 10 second delay can also be accounted for, if the size of the irregularities is about 3 times larger ($\sim 10^4$ to 10^5 km), and the density excess is 3 to 4 percent higher than the irregularities which cause CB of $\sim$ 1 second delay. For a typical emission gap of 100 kHz, the one dimensional cross-section of the irregularity works out to 10^3 km.

II. New microstructures in Type IV bursts at 137 MHz.

A high sensitivity ($\sim 10^{-23}$ Wm^{-2} Hz^{-1}) and high resolution ($\Delta t \sim$ 10 ms; $\Delta f \sim$ 60 kHz) spectrum analyzer operating near 137 MHz ($\pm$ 2 MHz) was put into operation in February 1978 at Ahmedabad. On May 7, 1978, new varieties of microscopic bursts, superimposed on type IV bursts were recorded from 0345 to 0500 UT. The main features of these bursts are: (i) spectra displaying "wave-like" emission covering 3 MHz frequency range, (ii) absorption of radiation on the high frequency side of burst with "fork-like" spectral shape and (iii) near simultaneous occurrence of bursts with slow and fast frequency drift rates on long and short time scales.

Acknowledgements

We thank Prof. D. Lal, Director of PRL, for his interest in this work. Financial support from this work has come from the Department of Space, Government of India. Thanks are also due to our staff who assisted in the maintenance of the equipment at SAC campus.

References

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DISCUSSION

Benz: Did I notice correctly that in the slow drift burst you showed, the emission ridge occurred at the low frequency side and the absorption band at the high frequency? In this case, this is different from the fiber bursts and requires a different explanation.

Bhonsle: Yes, that is correct.