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Decameter IIIb-III pairs

V.N. Melnik (1), H.O. Rucker (2), A.A. Konovalenko (1), V.V. Dorovskyy (1), and Shuncong Tan (3)
(1) Institute of Radio Astronomy of NANU, Kharkov, Ukraine, (melnik@ri.kharkov.ua, valentin_melnik@yahoo.com / Fax:+38-057-7061415), (2) Space Research Institute, Austrian Academy of Sciences, Graz, Austria, (3) Kharkov National University, Kharkov, Ukraine)

Abstract

In this paper we analyze the properties of type IIIb and type III bursts in IIIb-III pairs observed by radio telescope UTR-2 at frequencies 10-30 MHz. We discuss pro and contra of harmonic phenomenon of decameter IIIb-III pairs.

1. Introduction

It is well known that type III bursts are sometimes observed in pairs, which are harmonic pairs because the ratio of frequencies of bursts observed at the same time equals about 2:1 [1]. It is assumed that the bursts of the pairs are generated at fundamental and harmonic local plasma frequency. Type IIIb bursts differ from usual type III bursts by their fine frequency structure in the form of narrow-band stria [1]. Pairs consisting of IIIb and III bursts are also observed. From the time of their identification the problem whether these pairs are harmonically connectrd or not was brought up [2, 3]. As was shown in [3] their frequency ratio is about 2:1 as for usual pairs type III bursts. But at the same time there were some reasons not to consider these bursts connected harmonically [2]. Really type III bursts do not have fine frequency structure in the form of stria. Durations of type IIIb bursts and type III bursts are different. In this paper properties of decameter type IIIb and type III bursts in pairs observed by radio telescope UTR-2 at frequencies 10-30 MHz in July-August 2002 are studied. We find that duration of type IIIb and type III bursts in their pairs differs by about 3-4 times of magnitude at all frequencies. As a rule frequency drift rate of type IIIb bursts is higher than that for type III bursts. The ratio of frequencies in pairs of type IIIb-III bursts measured at the same time is close to 2.

2. Observations

Discussed in this paper IIIb-III pairs were observed in July-August 2002 by radio telescope UTR-2 at frequencies 10-30 MHz with the help of 60-channel spectrometer. Observations were carried out practically every day during 6 hours. In July-August 2002 several active regions passed over the solar disk. They were sources of sporadic solar radio emission in the form of type III bursts, type IIIb bursts, type IV bursts, type II bursts, drift pairs, S-bursts, spikes etc. Among them a lot of IIIb-III pairs were registered. We analyzed more than 400 such pairs, more than 100 in July and more than 300 in August. It is turned out that the most of IIIb-III pairs were registered on July, 19 and August, 15. The active regions № 256 and №249 were situated at 40°-50° to the East and to the West from the central meridian correspondingly on July, 19. At the same time the active region №289, with which solar radio activity was connected on August, 15 was placed at 40°-50° to the East from the central meridian. For measurement of the bursts parameters in IIIb-III pairs the whole frequency band 10-30 MHz was divided into five equal intervals. In each interval the average duration, interval between bursts, frequency drift rates and fluxes of bursts were measured. The average values of $T_1, T_2, T_3, df/dt_{III}$ and df/dt_{IIIb} for pairs observed on July, 19 and August, 15 are presented in Tables 1 and 2. Here df/dt_{III} and df/dt_{IIIb} are frequency drift rates of type III and IIIb bursts respectively. It is seen that duration of both type III and type IIIb bursts increase with frequency decreasing but their frequency ratios equal 3 and 4 for pairs observed on July 19 and August 15 correspondingly. The distance between bursts is a little smaller than type III burst duration. Drift rates of type IIIb bursts are larger than that for type III bursts. In Tables 3 and 4 ratios of frequencies for two bursts in IIIb-III pairs are shown. In all cases this ratio is very close to 2.

3. Discussion

The fact that active regions associated with IIIb-III pairs are placed at 40°-50° from the central meridian speaks in favor of harmonic connection of type IIIb and type III bursts. Really, the beam of fundamental radio emission is argued to be directed in the direction along the propagation of fast electrons. At the same time the beam of harmonic radio emission is considered to be perpendicular to the electrons propagation. So it is natural to suppose that simultaneous observations of both harmonics is more probable in the case when fast electron beams form angle of 40°-50° to the observer's direction, i.e. when corresponding active regions are placed at 40°-50° from the central meridian. The ratio of frequencies of type IIIb and type III bursts registered at the same time equals 2 as follows from Tables 3, 4. But there are some objections against harmonic theory of IIIb-III pairs. First of all the cause of absence of fine frequency structure in the form of stria for type III burst in IIIb-III pairs is unclear. Also it is not understandable why, if the source of both bursts in IIIb-III pair is the same electron beam, the durations of type IIIb and type III bursts is differed by 3-4 times of magnitude? At last there are some examples of IIIb-III pairs (an example of such pair is shown in Fig.1). We see that the bend in type IIIb burst observed at 15-22 MHz can be watched in following type III track at the same frequencies that is not in agreement with harmonic hypothesis. So, serious efforts of theorists are needed to definitively explain the IIIb-III pair phenomenon.

4. Figures

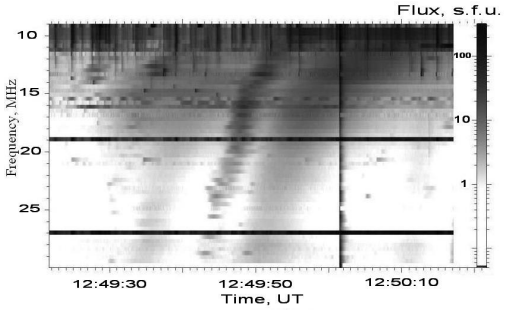

Figure 1: Dynamic spectrum of IIIb-III pair observed on July, 19 2002 at frequencies 10-30 MHz

5. Tables

Table 1: Average parameters for type IIIb and type III bursts in IIIb-III pairs observed on July 19

f, MHz	28	24	20	16	12
T_1, s	2.1	2.2	2.5	2.9	2.9
T_2, s	9.4	9.2	9.5	11	11.3
T_3, s	7.2	8.4	9.1	11	14.4
df/dt_{IIIb}, MHz/s	-4.8	-3.7	-2.7	-2.1	-1.4
df/dt_{III}, MHz/s	-4	-3	-2.1	-1.5	-1

Table 2: Average parameters for type IIIb and type III bursts in IIIb-III pairs observed on August 15

f, MHz	28	24	20	16	12
T_1, s	2.6	2.7	3	3.9	4
T_2, s	7.4	8.2	9.65	11.6	13.1
T_3, s	8.3	8.8	10.4	12.5	16.4
$df/dt_{IIIb,}$ MHz/s	-5	-4	-3	-2	-1.3
df/dt_{III}, MHz/s	-4.4	-3.1	-2.2	-1.5	-0.7

Table 3: Ratio f_{III}/f_{IIIb} for pairs observed on July 19, 2002

f, MHz	11	12	13	14	15
f_{III}/f_{IIIb}	1.96	1.96	1.95	1.96	1.9

Table 4: Ratio f_{III}/f_{IIIb} for pairs observed on August 15, 2002

f, MHz	11	12	13	14	15
f_{III}/f_{IIIb}	2.03	1.92	1.96	1.98	1.97

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